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ANNUAL

OF

SCIENTIFIC DISCOVERY:

OR,

YEAR-BOOK OF FACTS IN SCIENCE AND ART

FOR 1862.

EXHIBITING THE

MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS

IN

MECHANICS, USEFUL ARTS, NATURAL PHILOSOPHY, CHEMISTRY, ASTRONOMY, GEOLOGY, ZOOLOGY, BOTANY, MINERALOGY, METEOROLOGY, GEOGRAPHY, ANTIQUITIES, ETC.

TOGETHER WITH

NOTES ON THE PROGRESS OF SCIENCE DURING THE YEAR 1861; A LIST OF RECENT SCIENTIFIC PUBLICATIONS; OBITUARIES OF EMINENT SCIENTIFIC MEN, ETC.

EDITED BY

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NOTES BY THE EDITOR

ON THE

PROGRESS OF SCIENCE FOR THE YEAR 1861.

The fifteenth meeting of the American Association for the Advancement of Science was appointed to be held at Nashville, Tennessee, April, 1861; but, owing to the breaking out of the civil war, the meeting was necessarily postponed to some future and more auspicious occasion.

The thirty-first annual meeting of the British Association for the Advancement of Science was held at Manchester, September, 1861, Mr. William Fairbairn, the eminent engineer, being in the chair.

This meeting appears to have exceeded all others before held, in the numbers present, in the amount of general and local subscriptions (upon which the efficiency of the Association in promoting investigations mainly depends), in the value and number of the papers read, in the interest of the personal discussion, and in the excellence and variety of the evening discourses. Among the lectures of special interest was one by Professor Airy, the Astronomer Royal, "On the Solar Eclipse of 1860," and one by Prof. Miller, on the recent remarkable researches of Bunsen and Kirchhoff on "Spectrum Analysis;" abstracts of both being given in this volume. The subjects which commanded most general attention, however, among those brought before the Association, were the "*Origin and Antiquity of Man*" and "*Iron-plated Ships.*" The next meeting was appointed to be held at Cambridge, when the Prince of Wales is expected to take the chair.

From the annual address of the President, which was mainly a review of the recent progress of science, we make the following extracts: —

"Were I to enlarge on the relation of the achievements of science to the comforts and enjoyments of man, I should have to refer to the present epoch as one of the most important in the history of the world. At no former period did science contribute so much to the uses of life and the wants of society. And in doing this it has only been fulfilling

that mission which Bacon, the great father of modern science, appointed for it, when he wrote, that 'the legitimate goal of the sciences is the endowment of human life with new inventions and riches,' and when he sought for a natural philosophy which, not spending its energy on barren disquisitions, 'should be operative for the benefit and endowment of mankind.'

"Looking, then, to the fact that, whilst in our time all the sciences have yielded this fruit, I shall probably best discharge the duties of the office I have the honor to fill by stating, as briefly as possible, the more recent scientific discoveries which have so influenced the relations of social life.

"The history of man, throughout the gradations and changes which he undergoes in advancing from a primitive barbarism to a state of civilization, shows that he has been chiefly stimulated to the cultivation of science, and the development of his inventive powers, by the urgent necessity of providing for his wants and securing his safety. There is no nation, however barbarous, which does not inherit the germs of civilization, and there is scarcely any which has not done something towards applying the rudiments of science to the purposes of daily life.

"Again, if we compare man as he exists in small communities with his condition where large numbers are congregated together, we find that densely-populated countries are the most prolific in inventions, and advance most rapidly in science. Because the wants of the many are greater than those of the few, there is a more vigorous struggle against the natural limitations of supply, — a more careful husbanding of resources; and there are more minds at work.

"*Astronomy.* — Without tracing the details of the history of astronomical science, we may notice that in more recent times astronomical discoveries have been closely connected with high mechanical skill in the construction of instruments of precision. The telescope has enormously increased the catalogue of the fixed stars, or those 'landmarks of the universe,' as Sir John Herschel terms them, 'which never deceive the astronomer, navigator, or surveyor.' The number of known planets and asteroids has also been greatly enlarged. The discovery of Uranus resulted immediately from the perfection attained by Sir William Herschel in the construction of his telescope. More recently, the structure of the nebulæ has been unfolded through the application to their study of the colossal telescope of Lord Rosse.

"Our knowledge of the physical constitution of the central body of our system seems likely, at the present time, to be much increased. The spots on the sun's disk were noticed by Galileo and his contem-

poraries, and enabled them to ascertain the time of its rotation, and the inclination of its axis. They also correctly inferred, from their appearance, the existence of a luminous envelope, in which funnel-shaped depressions revealed a solid and dark nucleus. Just a century ago, Alexander Wilson indicated the presence of a second and less luminous envelope beneath the outer stratum; and his discovery was confirmed by Sir William Herschel, who was led to assume the presence of a double stratum of clouds, the upper intensely luminous, the lower gray, and forming the penumbra of the spots. Observations during eclipses have rendered probable the supposition that a third and outermost stratum of imperfect transparency encloses concentrically the other envelopes. Still more recently, the remarkable discoveries of Kirchhoff and Bunsen require us to believe that a solid or liquid photosphere is seen through an atmosphere containing iron, sodium, lithium, and other metals in a vaporous condition.

"*Magnetism.*— Guided by the same principles which have been so successful in Astronomy, its sister science, Magnetism, emerging from its infancy, has of late advanced rapidly in that stage of development which is marked by assiduous and systematic observation of the phenomena, by careful analysis and presentation of the facts which they disclose, and by the grouping of these in generalizations, which, when the basis on which they rest shall be more extended, will prepare the way for the conception of a general physical theory, in which all the phenomena shall be comprehended, whilst each shall receive its separate and satisfactory explanation.

"To refer to a single instance of the elucidation of magnetic phenomena, we have seen those *magnetic disturbances* — so mysterious in their origin, and so extensive in simultaneous prevalence, and which less than twenty years ago were designated by a term specially denoting that their laws were wholly unknown — traced to laws of periodical recurrences; revealing, without a doubt, their origin in the central body of our system, by inequalities which have for their respective periods the solar day, the solar year, and, still more remarkably, an until lately unsuspected solar cycle, of about ten of our terrestrial years, to whose existence they bear testimony, in conjunction with the solar spots, but whose nature and causes are in all other respects still wrapped in entire obscurity. We owe to General Sabine, especially, the recognition and study of these and other solar magnetic influences, and of the magnetic influence of the moon, similarly attested by concurrent determinations in many parts of the globe, which are now held to constitute a distinct branch of this science, not inappropriately named celestial,' as distinguished from purely terrestrial magnetism.

"*Chemistry.*—The most remarkable advance in this science is that made by Bunsen and Kirchhoff, in the application of the colored rays of the prism to analytical research. We may consider their discoveries as the commencement of a new era in analytical chemistry, from the extraordinary facilities they afford in the qualitative detection of the minutest traces of elementary bodies. The value of the method has been proved by the discovery of the new metals, cæsium and rubidium, by M. Bunsen; and it has yielded another remarkable result, in demonstrating the existence of iron, and six other known metals, in the sun.

"I must not, however, pass over in silence the valuable light which chemistry has recently thrown upon the composition of iron and steel. Although Despretz demonstrated many years ago that iron would combine with nitrogen, yet it was not until 1857 that Mr. C. Binks proved that nitrogen is an essential element of steel, and more recently M. Caron and M. Fremy have further elucidated this subject; the former showing that cyanogen, or cyanide of ammonium, is the essential element which converts wrought iron into steel; the latter combining iron with nitrogen through the medium of ammonia, and then converting it into steel by bringing it, at the proper temperature, into contact with common coal-gas. There is little doubt that in a few years these discoveries will enable Sheffield manufacturers to replace their present uncertain, cumbrous, and expensive process by a method at once simple and inexpensive, and so completely under control as to admit of any required degree of conversion being obtained with absolute certainty. Mr. Crace Calvert also has proved that cast-iron contains nitrogen, and has shown that it is a definite compound of carbon and iron, mixed with various proportions of metallic iron, according to its nature.

"*Geology.*—It is little more than half a century since Geology assumed the distinctive character of a science. Taking into consideration the aspects of nature in different epochs of the history of the earth, it has been found that the study of the changes at present going on in the world around us enables us to understand the past revolutions of the globe, and the conditions and circumstances under which strata have been formed, and organic remains imbedded and preserved. The geologist has increasingly tended to believe that the changes which have taken place on the face of the globe, from the earliest times to the present, are the result of agencies still at work. But whilst it is his high office to record the distribution of life in past ages, and the evidence of physical changes in the arrangement of land and water, his results hitherto have indicated no traces of its beginning, nor have they afforded evidence of the time of its future duration.

"*Applied Mechanics.* — During the last century the science of Applied Mechanics has made strides which astonish by their magnitude; but even these, it may reasonably be hoped, are but the promise of future and more wonderful enlargements."

Referring to the progress of steam navigation, Mr. Fairbairn remarked, "that the paddle-wheel system of propulsion has maintained its superiority over every other method yet adopted for the attainment of speed, as by it the best results are obtained, with the least expenditure of power."

"Great changes in the cultivation of the soil are undoubtedly destined to be effected by the steam-engine. It is but a short time since it was thought inapplicable to agricultural purposes, from its great weight and expense. But more recent experience has proved this to be a mistake; and already in most districts we find that it has been pressed into the service of the farm. The small locomotive, mounted on a frame with four wheels, travels from village to village, in Great Britain, with its attendant, the thrashing-machine, performing the operations of thrashing, winnowing, and cleaning, at less than one half the cost by the old and tedious process of hand labor. Its application to ploughing and tillage on a large scale is, in my opinion, still in its infancy; and I doubt not that many members of this Association will live to see the steam-plough in operation over the whole length and breadth of the land. Much has to be done before this important change can be successfully accomplished; but with the aid of the agriculturist in preparing the land so as to meet the requirements of steam-machinery, we may reasonably look forward to a new era in the cultivation of the soil.

"*Iron Ship-building.* — In iron ship-building, an immense field is opening before us. Our wooden walls have, to all appearance, seen their best days; and as one of the early pioneers in iron construction, as applied to ship-building, I am highly gratified to witness a change of opinion that augurs well for the security of the liberties of the country. From the commencement of iron ship-building, in 1830, to the present time, there could be only one opinion amongst those best acquainted with the subject, namely, that iron must eventually supersede timber in every form of naval construction. The large ocean steamers, the 'Himalaya,' the 'Persia,' and the 'Great Eastern,' abundantly show what can be done with iron; and we have only to look at the new system of casing ships with armor-plates to be convinced that we can no longer build wooden vessels of war with safety to our naval superiority and the best interests of the country. I give no opinion as to the details of the reconstruction of the navy; but I may state that I

am fully persuaded that the whole of our ships of war must be rebuilt of iron, and defended with iron armor calculated to resist projectiles of the heaviest description at high velocities.

"In the early stages of iron ship-building, I believe I was the first to show, by a long series of experiments, the superiority of wrought iron over every other description of material in security and strength, when judiciously applied in the construction of ships of every class. Other considerations, however, affect the question of vessels of war; and although numerous experiments were made, yet none of the targets were on a scale sufficient to resist more than a six-pounder shot. It was reserved for our scientific neighbors, the French, to introduce thick iron plates as a defensive armor for ships. The success which has attended the adoption of this new system of defence affords the prospect of invulnerable ships of war; and hence the desire of the government to remodel the navy on an entirely new principle of construction, in order that we may retain its superiority as the great bulwark of the nation.

"It is asserted, probably with truth, that whatever thickness of plates are adopted for casing ships, guns will be constructed capable of destroying them. But their destruction will even then be a work of time; and I believe, from what I have seen in recent experiments, that, with proper armor, it will require not only the most powerful ordnance, but also a great concentration of fire, before fracture will ensue. If this be the case, a well-constructed iron ship, covered with sound plates, of the proper thickness, firmly attached to its sides, will, for a considerable time, resist the heaviest guns which can be brought to bear against it, and be practically shot-proof. But our present means are inadequate for the production of large masses of iron; and we may trust that, with new tools and machinery, and the skill, energy, and perseverence of our manufacturers, every difficulty will be overcome, and armor-plates produced which will resist the heaviest existing ordnance.

"The rifling of heavy ordnance, the introduction of wrought iron, and the new principle of construction with strained hoops, have given to all countries the means of increasing enormously the destructive power of their ordnance. One of the results of this introduction of wrought iron and correct principles of manufacture is the reduction of the weight of the new guns to about two-thirds the weight of the older cast-iron ordnance. Hence follows the facility with which guns of much greater power can be worked, whilst the range and precision of fire are at the same time increased.

"*Iron Bridges.*—We have seen a new era in the history of the

construction of bridges, resulting from the use of iron; and we have only to examine those of the tubular form over the Conway and Menai Straits to be convinced of the durability, strength, and lightness of tubular constructions applied to the support of railways or common roads, in spans which, ten years ago, were considered beyond the reach of human skill. When it is considered that stone bridges do not exceed one hundred and fifty feet in span, nor cast-iron bridges two hundred and fifty feet, we can estimate the progress which has been made in crossing rivers four or five hundred feet in width, without any support at the middle of the stream. Even spans greatly in excess of this may be bridged over with safety, provided we do not exceed eighteen hundred to two thousand feet, when the structure would be destroyed by its own weight.

"*Importance of Good Machinery.*—It is to the exactitude and accuracy of our machine-tools that our machinery of the present time owes its smoothness of motion and certainty of action. When I first entered Manchester, the whole of the machinery was executed by hand. There were neither planing, slotting, nor shaping machines; and, with the exception of very imperfect lathes, and a few drills, the preparatory operations of construction were effected entirely by the hands of the workmen. Now everything is done by machine-tools, with a degree of accuracy which the unaided hand could never accomplish. The automaton, or self-acting machine-tool, has within itself an almost creative power; in fact, so great are its powers of adaptation that there is no operation of the human hand that it does not imitate.

"*Telegraphy.*—A brief allusion must be made to that marvellous discovery which has given to the present generation the power to turn the spark of heaven to the uses of speech;—to transmit along the slender wire, for a thousand miles, a current of electricity that renders intelligible words and thoughts.

"In land telegraphy the chief difficulties have been surmounted, but in submarine telegraphy much remains to be accomplished. Failures have been repeated so often as to call for a commission on the part of the British Government to inquire into the causes, and the best means of overcoming the difficulties which present themselves. I had the honor to serve on that commission, and I believe that from the report, and mass of evidence and experimental research accumulated, the public will derive very important information. It is well known that three conditions are essential to success in the construction of ocean telegraphs,—perfect insulation, external protection, and appropriate apparatus for laying the cable safely on its ocean bed. That we are far from having succeeded in fulfilling these conditions is evident from the fact

that out of twelve thousand miles of submarine cable which have been laid since 1851, only three thousand miles are actually in working order; so that three-fourths may be considered a failure and loss to the country. The insulators hitherto employed are subject to deterioration from mechanical violence, from chemical decomposition or decay, and from the absorption of water. But the last circumstance does not appear to influence seriously the durability of cables. Electrically, India-rubber possesses high advantages, and, next to it, Wray's compound and pure gutta-percha far surpass the commercial gutta-percha hitherto employed; but it remains to be seen whether the mechanical and commercial difficulties in the employment of these new materials can be successfully overcome. The external protecting covering is still a subject of anxious consideration. The objections to iron wire are its weight and liability to corrosion. Hemp has been substituted, but at present with no satisfactory result. All these difficulties, together with those connected with the coiling and paying out of the cable, will no doubt yield to careful experiment, and the employment of proper instruments in its construction, and its final deposit on the bed of the ocean.

"Irrespective of inland and international telegraphy, a new system of communication has been introduced by Prof. Wheatstone, whereby intercourse can be carried on between private families, public offices, and the works of merchants and manufacturers. This application of electric currents cannot be too highly appreciated, from its great efficiency and comparatively small expense. To show to what an extent this improvement has been carried, I may state that one thousand wires, in a perfect state of insulation, may be formed into a rope not exceeding half an inch in diameter."

The Congress for the Promotion of Social Science, which has now become an established institution in Great Britain, met, during the past year, at Dublin, and was largely attended,—some ninety-three papers being read and discussed. Of these communications we note the following, by title, as affording our American readers an idea of the scope and objects of the Congress:—

"Suggestions on the Failure of Education in the Junior Classes of Elementary Schools; by the Rev. W. A. Willock, D.D." "On the Application of the Principles of Education in Schools for the Lower Classes of Society; by Miss Carpenter." "A Scheme for the Adult Education of the Working Classes; by Mr. J. P. Organ." "Paper-hangings Auxiliaries to Education; by Mr. J. Stewart." "On the Influence of Newspapers on Popular Education; by Mr. G. W. Blanchard Jerrold." "On Art Education considered in its Utilitarian and

Social Aspect; by Mr. M. A. Hayes." "On the more Prominent Causes of an Excessive Mortality in Early Life; by Dr. Moore." "On the Physical Degeneration of Town Populations; by Dr. Beddoe." "On Hospital Statistics; by Florence Nightingale." "On the Influence of the Food on the Intellect; by Dr. H. Kennedy." "On the Health of Merchant Seamen; by Dr. J. O. William." "On Practical Sanitary Work in Town and Country; by Mrs. Fison." "On Quarantine; by Dr. Milroy." "On the Application of Sanitary Science to Public Works of Irrigation; by Mr. E. Chadwick." "On the Disposal of Boys from Reformatories; by the Rev. J. Fish." "On Sentences, with a view to Reformation or Deterrence; by T. B. L. Baker." "On Punishment, — its Effects by way of Example; by Mr. C. H. Foote." "On the Condition of the Working Women in England and France; by Miss Parkes." "Women Compositors; by Miss Emily Faithfull." "On the Law of Fluctuation in Wages; by Prof. H. Hennessy." "On Working Men's Reading-rooms; by Dr. R. Elliott." "On the Condition of the Working Classes and their Dwellings; by the Rev. J. B. Robinson." "On the Superior Economy of Administration of Voluntary as distinguished from Legal Charity; by Major O'Reilly." "On the Necessity of a Universal System of Weights, Measures, and Coinage; by M. Chevalier, of France." "On Public Prosecutors in Prussia; by Baron Holtzendorff." "Should the Accounts of Joint Stock Companies be Audited by a Public Officer? by Mr. D. C. Heron." "Observations on the Proposal of Admitting the Evidence of Accused Persons on their Trial; by Mr. P. J. McKenna."

The Emperor of Russia has recently placed in the hands of M. Struvé, the distinguished Russian astronomer, the sum of 125,000 francs, to enable him to erect an observatory on the summit of Mount Ararat, in Persia. It is hoped that, under the remarkably clear skies of this country, important astronomical results will be attained to.

A scientific expedition has been set on foot by the Government of India, for the exploration of the great mountain chains of Central Asia. It will consist of five men of science, — geologists and physicists, — who, early in 1862, will traverse the Himalaya and Karchan chains, and, proceeding into Tartary, explore the great Thian-Chan; then, passing eastwards, return to Hindustan by the gorges of the Brahmaputra River.

An English commission is now engaged, in coöperation with a commission appointed by the French Government, for the purpose of connecting the triangulation of Great Britain with that of France and Belgium. The ultimate result to be obtained is the substitution of one meridional line for the lines of Greenwich, Paris, and St. Petersburg,

that are at present in use in different countries, and thus to harmonize the maps of all countries. The connection of the French and Russian systems will be carried out by the officers of those countries.

Uriah A. Boyden, Esq., of Boston, Mass., has deposited with the Franklin Institute, of Philadelphia, the sum of one thousand dollars, to be awarded as a premium to "any resident of North America who shall determine by experiment whether all rays of light, and other physical rays, are or are not transmitted with the same velocity." The award is to be made by a committee of three citizens of the United States, of competent scientific ability, to be appointed by the managers of the Institute.

Prof. Torrey, of New York, the well-known botanist, has presented to Columbia College his immense *herbarium*, — the fruit of forty years' assiduous labor, — together with his valuable botanical library. The herbarium is especially rich in North American plants, as it contains full sets of nearly all the collections made by the numerous exploring expeditions of the United States Government, from that of Maj. Long, in 1819, to the present time, and the original specimens from which the descriptions in the official reports were made. The herbarium is also authority for the plants described in the Flora of North America, by Dr. Torrey and Dr. Gray. The Floras of Europe, Asia, the Cape of Good Hope, Australia, and many other parts of the world, are largely represented by collections named by the highest authority.

Patents. — Within the past year some important changes have been made by Congress in the United States system of Patent Laws, of which the following are the most noticeable: —

Under the new system, pictures, prints, and artistic designs of every description, may be patented, and no person can use or duplicate the same without the consent of the originator. Merchants may obtain patents upon their *trade marks*, and even upon *the labels* which they affix to their goods. This provision also covers, in particular, ornamental designs in any fabric or material; every new style of tool or pattern used or produced in any trade; and ornaments and decorations formed from any material. In short, any *new form* of any article of manufacture may be patented. Makers of such articles will therefore be encouraged to exercise ingenuity in producing improved forms, so as to enjoy a monopoly of the sale thereof.

Patents can be taken out under the new system, in accordance with the above provisions, for three and one-half, seven, or fourteen years, as the applicant desires; and the following is the tariff of fees established by Congress for the same: —

For a patent of three and one-half years, ten dollars; for a patent

of seven years, fifteen dollars; for a patent of fourteen years, thirty dollars. The documents required are petition, affidavit, specifications, and drawings; a model being unnecessary.

Recent Progress in Natural History. — Professor Owen, of England, gives the following as the ratio at which our knowledge of the class of mammalia has advanced during the last thirty years; namely, from, say 1,350 species in 1830, to 2,500 in 1860. In one order, *e.g.* Marsupialia, the increase has been, from 50 species, recorded in 1830, to 350 species in 1860. We should also, says Professor Owen, greatly over-estimate our present knowledge, were we to rest upon it a conclusion that there remained but very few more forms of Mammalia to provide room for in our museums; an assertion which derives strength from the great augmentation of the species of the Quadrimanous (apes) order, recently made through the researches of Du Chaillu and others in tropical Africa.

The Smithsonian Institution has recently made arrangements for the preparation of works on the different orders of insects found in North America, with a view to identifying the species, and of systematizing the study of their relations and habits. This is a subject not only of much scientific interest, but also of great practical importance in regard to its connection with agriculture. When it is considered how much loss is annually caused in this country by the ravages of the Hessian fly, the army and cotton worms, the curculio, the grasshopper, and numerous other species of insects, it must be evident that anything that may tend, in however slight a degree, to throw light upon the means of preventing such ravages, is of great commercial importance. But before we can make use of the experience of other countries on this subject, it will be necessary to identify the insects, since, in regard to them, as well as other objects of natural history, the same name is often popularly applied to widely different species.

The greatest deficiency in American natural history is to be found in the department of entomology, there being no original treatise in reference to this country, applicable to the wants of the present day. The Institution has therefore made arrangements with eminent entomologists for the preparation of the following series of reports on the different orders, in the form of systematic lists, of all the North American species hitherto described, and an account of the different families and genera, and, whenever practicable, of the species of each order, — namely:

Coleoptera (beetles, etc.), by Dr. John L. Le Conte, of Philadelphia. Neuroptera (dragonflies, etc.), by Dr. Hagen, Königsberg. Hymenoptera (wasps, bees, etc.), by H. De Saussure, Geneva. Diptera

(flies, mosquitoes, etc.), by Baron Ostensacken, of the Russian legation at Washington. Lepidoptera (butterflies, moths, etc.), by Dr. J. G. Morris, Baltimore, and by Dr. B. Clemens, Easton, Pa. Hemiptera (chinches, roaches, etc.), by P. R. Uhler, Baltimore.

Catalogues of the Coleoptera, Diptera and Lepidoptera have been already published.

In Europe, especially in France, the subject of the acclimatization of new and the improving of old breeds of animals continues to receive great attention. During the last few years there have been introduced and acclimatized in France, mainly through the auspices of the *Jardin des Plantes*, at Paris, the following new species: two new and hardy varieties of the silk-worm; ten species of ornamental birds; and five species of domestic mammalia, namely: the lama, which already counts three generations at the *Jardin des Plantes;* the yak, or Thibet ox, which in two generations has increased to seventeen individuals, including the three original ones; and the hemione, the canna, and nilgau (varieties of deer or antelope from South Africa). These three animals all furnish excellent meat; that of the nilgau has already been served up at several tables in Europe.

The Belgian and Danish governments, during the past year, have appointed commissioners to study the new methods of propagating and rearing fish, and to introduce the same among the fishing population of their respective shores. Legislative action has also been recently taken by the French government (see Zoology, this volume) for the protection of useful birds, with a view of checking the increase of insects injurious to vegetation. M. St. Hilaire, the late eminent naturalist, in presenting to the French Academy, during the past year, the fourth edition of his work, *Acclimatization and Domestication*, remarked, that breeding alone, in most civilized countries, had become a regular business with the agriculturist; but in the way of preserving the animals we have, whether wild or domestic, or turning them to the best account, we at present display but little more wisdom than in the Middle Ages; and sportsmen of every nation kill the most useful birds, — such as the swallow, for instance, — for no purpose whatever but the stupid pleasure of killing. Let a goat-sucker or owl be seen by a farmer, he will hunt it down forthwith, and proudly nail its carcass to his barn-door, quite unconscious of having shot one of his best friends, whose only pursuit was that of destroying the vermin on his ground.

The Lowest Race of Men. — At the last meeting of the British Association (1861), Professor Owen stated that he regarded the natives of the Andaman Islands, in the Indian Ocean, as probably the most

primitive, or lowest in the scale of civilization, of the human race. Of low stature (probably less than five feet on an average), they are described by most observers as *dwarf negroes;* but have none of the distinctive characteristics of the African race. They have no tradition, and apparently no notion of their origin; are reported to have no notions of a Deity, of spiritual beings, or of a future state. Both sexes go naked, without any sense of shame, and indulge their sensual appetites in the simplest animal fashion. Entirely destitute of clothing, utterly ignorant of agriculture, living in the most primitive and rudest form of habitations, their only care seems to be the supply of their daily food. They are not, however, cannibals. Their implements are bows and arrows, rude spears, and nets; and finding that these suffice for the acquirement of food, they have carried their inventive faculties no further.

In reviewing the scientific history of the past year, the most noticeable events (described at length elsewhere in the present volume) may be enumerated substantially as follows:—1. The extraordinary attention given in both Europe and the United States to the invention and improvement of warlike enginery and material; the results of which bid fair to almost revolutionize the heretofore accepted science of warfare. In the United States, owing the paralyzation of many forms of industry by the civil war, the inventive skill of the country has been largely directed to this subject, and more inventions relative to war-implements and constructions have been brought out during the twelve months of 1861, than in any equal former period of history. Many of these are undoubtedly of little value, while others are of great and acknowledged importance. The "Rodman," "Parrot," and "Sawyer" guns; the novel "Ericsson's floating battery;" Juan Patterson's system of iron-plating; and the new compressed powder, are examples of late American inventions belonging to the latter class. 2. The completion and effective maintenance of a line of telegraph across the American Continent, from the Mississippi to the Pacific. 3. The general announcement of Bunsen and Kirchhoff's new system of spectrum analysis, and the consequent discovery of three new elementary substances.* 4. Fremy's investigations into the nature and manufacture

* More recent experiments would seem to show, that more has possibly been claimed for the researches of Bunsen and Kirchhoff than can be established, and that some of their conclusions have been too hasty, especially those respecting the composition of the sun. Thus it has been recently ascertained that the bright lines in the spectrum of a burning body vary with the temperature of the flame in which the body is burned. Professor Frankland, in a letter to Dr. Tyndall, published in a late number of the London *Philosophical Magazine*, says:—"I have just made some further experiments on the lithium spectrum, and they conclu-

of steel. 5. The continued accumulation of evidence respecting the geological history of the human race. 6. The discovery of *ten* new asteroidal planets. 7. The appearance and near approach to the earth of a brilliant and heretofore unrecognized comet.

The value of the laws deduced by modern scientific research for the preservation of health and the prevention of desease have also received a most striking illustration during the past year from the efforts and action of the United States Sanitary Commission. Through their labors and counsels mainly, an army of over five hundred thousand men, unaccustomed to the life of a soldier, drawn from city, farm, and factory, and brought into the field with scarcely an idea on their part of the insalubrious influences which are the invariable accompaniments of such gatherings, have been kept in a condition of health, entirely unparalleled in history. Such a result contrasts strongly with the condition of the British army in the Crimea in 1854; which, at no time exceeding thirty thousand men, lost of this number, from *disease*, in seven months, over thirteen thousand soldiers.

Among the scientific publications of the past year especially worthy of note we may mention the following: —

Report of Maj. Alfred Mordecai, of the Military Commission to Europe in 1855–6. This work, published by Congress, embodies descriptions of all the recent improvements and experiments made in the various countries of Europe during the last few years in relation to ordnance, ordnance material, and infantry arms, especially rifled weapons. It includes a valuable work by Capt. Schon, of Saxony, on rifled infantry arms, translated by Capt. J. Gorgas, U. S. A.; a description of the new French system of field artillery; the construction of shot, bombs, fuses, transportation of ammunition, use of gun-cotton by the Austrians, and a summary of the recent experiments in relation to rifled cannon and small arms in England.

Report upon the Physics and Hydraulics of the Mississippi River; upon the Protection of the Alluvial Region against Overflow; and upon

sively prove that the appearance of the blue line entirely depends upon temperature. The spectrum of chloride of lithium ignited in a Bunsen's burner flame does not disclose the faintest trace of the blue line. Replace the Bunsen's burner by a jet of hydrogen, — the temperature of which is higher than that of the Bunsen's burner, — and the blue line appears, faint, it is true, but sharp and quite unmistakable. If oxygen be now slowly turned into the jet, the brilliancy of the blue line increases until the temperature of the flame rises high enough to fuse the platinum, and thus puts an end to the experiment."

If, therefore, the lines of the spectra vary with the temperature of the burning bodies, and if the temperature of the sun is really much higher than any produced artificially, it is obviously doubtful whether we can tell what substances do, or do not, produce the fixed lines visible in the solar spectrum.

the Deepening of the Mouths; based upon Surveys and Investigations, made under the Acts of Congress directing the Topographical and Hydrographical Survey of the Delta of the Mississippi River, with such Investigations as might lead to the determination of the most practicable plan for securing it from inundation, and the best mode of deepening the channels at the mouths of the river. Prepared by Capt. A. A. Humphreys and Lieut. H. L. Abbot, Corps of Topographical Engineers, U. S. Army; — with maps; pp. 545.

This work, which forms one of the professional papers of the U. S. Corps of Topographical Engineers, is one of the most elaborate scientific reports ever prepared in this country, and, besides its immediate practical value, contains much information important to the geologist, meteorologist, and to civil engineers generally. It also contains a very full discussion of the theory of hydraulics as applied to rivers.

The Birds of North America, containing Descriptions of all known Species, chiefly from specimens in the Museum of the Smithsonian Institution. By S. F. Baird, with the co-operation of John Cassin and George N. Laurence; one vol. 4to, with an atlas of one hundred plates, from original drawings, representing one hundred and forty-eight new and unfigured North American birds. A work of this description has been long admitted to be a great desideratum, on account of the numerous additions to our ornithology, and the fact also that there was no work extant which presented a complete and condensed account of all the known birds of the United States to the present time. The magnificent and standard Ornithology of Mr. Audubon, the second edition of which was completed in 1843, embraced very nearly all that was known at that time of the birds of the accessible regions of North America, and contained descriptions and figures of nearly five hundred species. Seventeen years have produced great changes, not only in the boundaries and geographical relations of the United States, but also in the facilities for travel and scientific exploration of the interior and remote regions of our vast territory. Within that period, the thorough exploration of Texas, New Mexico, the countries on the Pacific slope, the Rocky Mountains, and other very extensive and interesting districts of our country, by government expeditions and private enterprise, has correspondingly enlarged our knowledge of North American zoology, and especially of ornithology. In the Eastern and older States, too, quite numerous additions have been made, which, especially in Florida, and elsewhere on the Atlantic seaboard, have been of a very interesting character.

So great has been the increase, from causes here indicated, and the discovery of new birds, that instead of about 495 species of North

American birds, known to Mr. Audubon, there are 716 species given in the present work, being 221 more than are contained in the works of that celebrated author. In the present work, also, the birds of the United States for the first time are arranged in the genera and families established by modern naturalists, and no exertion has been spared, we believe, by the distinguished naturalists who have undertaken its preparation, to present a work in all respects a complete Ornithology of the United States.

New Theorems, Tables and Diagrams for the Computation of Earthwork; illustrated by numerous original engravings, and a series of lithographic drawings from models, showing all the solid forms which occur in railroad excavations and embankments; by John Warner, A. M., author of Studies in Organic Morphology, etc. This work, a complete manual for the mensuration of railroad excavations and embankments, of shafts, tunnels and workings in mines, contains, also, a separate theoretical treatise, and an appendix on graphical processes, the methods of equivalent square bases and equivalent level heights; and is splendidly illustrated with plates, scales and diagrams of all the combinations of solids in earthwork, — the whole the result of immense labor and original research on the part of the author.

Catalogue of the Fishes of the Eastern Coast of North America, from Greenland to Georgia, by Theodore Gill. This work, which forms a part of the Proceedings of the Academy of Natural Sciences of Philadelphia, and has also been published separately, gives as complete an enumeration of the fishes that inhabit the waters that bound our continent, as the present state of ichthyological science will admit.

The Appendix of the Report of the Smithsonian Institution for 1860 (published in 1861) contains much valuable scientific information, presented in a popular manner. Among the subjects treated of, we may specify the following:—"*Lectures on Mollusca or 'Shellfish' and their Allies*," by Philip P. Carpenter, Ph. D., of England; "*Lectures on Roads and Bridges*," by Fairman Rogers, Professor of Civil Engineering, University of Pennsylvania; "*General Views on Archæology*," by A. Marlot, of Lausanne, Switzerland; "*The Microscope*," translated from "Aus der Natur, etc." Leipzig, 1858; "*Cuvier's Memoir of Haüy*," translated by C. A. Alexander; "*Notices of the Progress of our Knowledge regarding Magnetic Storms*," by Gen. Edward Sabine, of England; etc. etc.

We present to the readers of the *Annual of Scientific Discovery* for 1862, the portrait of CAPT. JOHN A. DAHLGREN, U. S. N. — distinguished in science for his researches and discoveries in relation to ordnance and projectiles.

THE

ANNUAL OF SCIENTIFIC DISCOVERY.

MECHANICS AND USEFUL ARTS.

THE GREAT INTERNATIONAL EXHIBITION OF 1862.

THE second great English Exhibition of the Industry of All Nations having been appointed for the present year (1862), the commissioners intrusted with the direction of the same have made arrangements for opening the Exhibition on a most extensive scale on the 1st of May next. Warned by the experience gained in 1851, at Paris in 1855, the Manchester Art-Treasures of 1857, and the Crystal Palace, the commissioners resolved that the new building should be formed of more weather-tight materials than iron and glass, at least in those portions devoted to the reception of works of art. Without some such provision for the safety of pictures there was no chance of getting loans to any extent, more than one mishap having, reasonably enough, disposed owners against incurring risks of the like nature over again. Accordingly, a very large portion of the new construction is to be of brick, the roofs supported on cast-iron pillars, the roof itself of wood, protected by felt, and painted. Thus much for the materials; now of the form and architectural characterof the edifice.

The dimensions of the site of the building are 1,152 feet from east to west, and 692 feet 6 inches from north to south: the measures, however, being exclusive of a wing devoted to machinery, the area of which is 872 feet by 200 feet, going directly north and south, at a right angle, therefore, to the main construction. Looking at the southern façade will furnish the most striking view of the whole exterior, which is arranged thus: The whole stretch of the front proper is nearly on a level from end to end, of the height of about sixty feet; behind this, and overlooking it in some degree, will run the loftier

roof of the nave, 100 feet in height; at each end rises an enormous dome, 250 feet high and 160 feet in diameter at its base. When it is remembered that the dome of St. Paul's is but 108 in diameter and St. Peter's but 139, some idea of the huge vault it is proposed to rear will be obtained. The form of these domes appears to be octangular, terminating in a pinnacle, and with a reverted curve, like an ogee moulding, for general outline. The exterior aspect of the great façade presents four sections, divided by porches of differing dimensions.

Reverting to the ground plan of the building, we may briefly point out that its general form is that of the letter L, the short limb being that intended for the reception of machinery. At each end of the long limb arise the enormous domes; along the front of this, farthest removed from the short limb, is the façade we have just described; this façade is the front of the space devoted to the pictures, will be built of brick, and, of course, intended to be of a permanent nature. The upper portion only of this will be devoted to art; the lower galleries, on a level with the road, being appropriated to other objects, amongst which carriages and still machinery will find place. The picture galleries will therefore be 1,200 feet long; down the middle runs a dividing wall, doubling the hanging space, forming two galleries parallel to each other, 55 feet wide by 35 feet high. The result will be 4,600 feet of wall space: a space enormous, no doubt, but by no means enough, if all the probable requirements are to be fully met. The plan of lighting is to be from a clerestory range of windows, the roof being solid.

We are now fairly in the interior of the edifice, and may take a stand at either end under the dome, and look down the vast nave, which is in an unbroken line from end to end. As at present designed, there will be under each of these domes a raised platform or dais, elevated a few feet from the floor, — a post of advantage for looking over all the vast range of vistas that open before us. The general character of the design for these interiors is not without a suggestive Gothicism. The height of the nave, which forms the centre, is about 100 feet, — the roof pitched from the centre at a low angle, of wood, covered with felt, as we said before. This roof is to be supported by cast-iron columns; these columns, about midway of their height,—which is about the same as the exterior wall, — sustain a gallery running entirely round the nave above this, at an equal distance to that at which the first gallery stands above the floor; the columns terminate in an ornamental capital; from this rise gigantic spanners of semicircular form, which leap over the whole nave from side to side, the space between them and the sloping roof-sides being filled by trusses and ties, architecturally disposed; — thus there exists what may be called a spandril over each arching semi-circular spanner. The cast-iron columns are banded midway of their height. The splendid picturesqueness of effect gained by this general arrangement may be surmised readily. Great character is given by allowing the timber ribs of the roof to be visible above all. The columns are slightly advanced into the nave, so that a sort of recess is formed by each. Behind each is a second but subordinate shafting, of square form; this will do duty mainly for the support of the galleries, that of the roof going to the columns. Both are of cast-iron. The spanners have cusps upon

their edges, are decorated in simple forms, and will be painted of a cheerful color. The whole is lighted from a clerestory.

Having thus described the structure and general character of the building, we may state some further particulars of interest. From the 1st of May to the 15th of October is to be the period of its existence, as it was that of the 1851 gathering. The ground occupied by the whole building is more than twenty-six acres; that of the 1851 Exhibition being but twenty-three. The space of the flooring will be 1,140,000 feet; nearly 200,000 feet more than its predecessor, without counting nearly 300,000 feet more that will be gained by the appropriation of the wing building to machinery. One hundred and sixty feet was the greatest height of 1851, the nave being sixty feet high by seventy-two feet wide. The forthcoming building will be 260 feet at its greatest height, that of the domes; the nave, 1,200 feet long, 85 wide, and 100 feet high. The first building was 1,800 feet long by 400 wide; the present, as before, 1,200 feet long and 700 wide; the machinery nearly 1,000 feet long by 220 wide. Messrs. Kelk & Lucas, the contractors, have undertaken the erection at the price of £200,000, its estimated cost being £300,000,—the remaining £100,000 being to be paid over to them in case the profits amount to more than £500,000, as they did in 1851.

RECONSTRUCTION OF THE ROMAN GALLEY.

During the past year, the Emperor of the French has caused to be built a vessel on the plan of the ancient Roman galley, or *trireme*, which has excited much attention and interest among persons who occupy themselves with naval archæology. The emperor, in ordering the execution of this vessel, had for object to throw light on the disputed question of the old row-galleys, known by the name of triremes. No precise description of these vessels has come down to our times, and we can only form an opinion of them from some bassi relievi and scattered passages in ancient authors. In spite of the researches of *savans*, among whom may be mentioned those of M. Gal, historiographer of the marine, the exact meaning of the word trireme could not be decided on. Now the problem of three rows of oars placed one over the other appears to be practically solved by the experiment which the emperor has had made. The trireme now at St. Cloud is 40 metres (131ft. 3in.) long at the water-mark, 5½ metres (18ft. 3in.) wide, and drawing 1m. 10c. (3ft. 7in.) of water. She is propelled by 130 oars, 65 on either side, each moved by one man. They are arranged in three rows; the lower one is under a covered deck, which explains the name of *talamites* (*talamos*, room under the deck), by which the ancient authors distinguished these rowers; the other two rows are open, and the oars of the upper row pass behind the heads of those of the row under them. This arrangement also explains the name *zygites* (*zugos*, yoke), given to the latter, as well as that of *tranites* (*tranos*, throne), applied to the men on the upper benches. Two rudders are placed, according to the indication of the ancient bassi relievi. The bow is armed at the water's edge with the *rostrum*, a spear with three points, intended to pierce and lay open the sides of the enemy's vessels.

Upon the occasion of a visit to the galley by the imperial party, all the rowers were at their posts, and immediately, at a signal from the commanding officer, all the oars were in movement with perfect regularity, although the men had received but little drilling. The galley on leaving St. Cloud went down the river towards Neuilly-bridge. Her speed, allowing for that of the current, was five and a half knots an hour. Before reaching the bridge at Neuilly the trireme was turned round by the action of her rudders and the oars on one side backing water, while the others pulled as before, after which she again ascended the river to St. Cloud. During the passage back the emperor had different experiments made of the action of the different rows of oars, suppressing in succession that of the talamites, the zygites, or the tranites.

BOAT—BUILDING BY MACHINERY.

We presume it is tolerably well known that a boat is made of a great variety of pieces of wood, separately sawed and shaped and then put together. Mr. Nathan Thompson, of New York City, has invented a machine, or rather several machines, working together by the perfection of mechanism and driven rapidly by steam, which cuts, hammers, saws, and bolts in rapid succession the component parts of a boat, with a magic-like rapidity.

Mr. Thompson has been nineteen years in perfecting his machinery, which originally was very elaborate, but is now reduced to thirteen separate machines, which work simultaneously. When the various parts of a boat have been perfected in twelve of the machines, the thirteenth puts them together. This latter is termed by the inventor his "patent assembling form." It is in reality the reversed framework or shell of a model boat,—a kind of boat mould, if one might employ such an expression. It is a frame adapted to receive all the parts of the boat, to hold them together firmly in their proper places, and to retain them there until the easy work of bolting and screwing has been thus expeditiously performed, and the perfected craft is lifted off the "assembling form," and pronounced ready for sea.

The framework is so arranged that every piece and joint of the boat finds a fitting place upon it, and the craft is thus put together somewhat as the portions of a dissecting map may be combined. The wonderful simplicity of the whole system, and the marvellous perfection of the separate pieces of machinery which carry out the objects, are described as astonishing. For instance, a skilled workman of uncommon energy can make, under the present system, twenty ribs in a day. Mr. Thompson's rib-making machine can be thoroughly explained to the most ordinary field laborer in a few hours; and the individual thus taken from the spade to be converted into a naval architect can, after six hours' instruction, turn out five hundred ribs as the result of a day's work. The machine which shapes and planes beams, with a convex surface on one side and a concave on the other, exactly corresponding to curves which had been previously determined, and regulated by a process beautifully simple and certain, is, perhaps, at once the most important and the most novel of all the mechanical appliances which the inventor has introduced. A very

singular piece of machinery is that which Mr. Thompson styles the "drunken saw;" a small circular saw, working with an extraordinarily eccentric and staggering motion, biting pieces out of the wood it operates on at either side, and thus turning out a grating or trellis-work in a manner very marvellous to see, but utterly defiant of description.

The thirteen machines are in detail described as follows:—

The first machine is for holding the gunwales, risings, floor-timbers, cants, keels, stem, sternpost, and board in their relative positions, as designed in the finished boat. The second is the combination-saw, for all kinds and dimensions of stuff, either square, bevelling, or angling, that can be sawed with a circular saw, and to any desired width or taper without measuring. The third is the patent form for spiling, or giving the plank edge the required bevel throughout its entire length. The fourth is for giving the proper bevel to the stern board, thwart-knees, transom-knees, breast hooks, risings, forward and stern ribs, cants, sternsheets, gratings, etc. The fifth is for boarding and rebating keels at a single operation, and in the most perfect manner. The sixth machine is for tenoning toggles. The seventh, for marking and slotting gunwales to receive their toggles and row-locks. The eighth is the eccentric saw for grooving, grating, etc. The ninth for giving the ribs their required bevel. The tenth for planing a plank on both sides at one operation, at the same time giving its interior and exterior curve in the most perfect manner, and uniform in thickness throughout its entire length. The eleventh is a machine for planing perfectly plain surfaces. The twelfth is for moulding toggles, bottom-boards, gunwales, and risers, and it cuts any bevel or irregular mould, or three sides, or planes three flat surfaces at a single operation. The thirteenth and last machine is for bending the ribs to any form or size required in boat-building.

Mr. Thompson undertakes to produce a large-size boat in five hours, and at a cost of about one-tenth that paid by the government for a similar boat.

THE FUTURE OF HIGH PRESSURE STEAM.

At the recent opening of a School of Science at Liverpool, Mr. Fairbairn said:—"As a laborer in the field of science, more particularly practical science, I am sure you will allow me to give you a few examples of the great advantages which the industrial arts receive from the exact sciences, and particularly from those constructions which are of much greater advantage to the industry and property of the community. With regard to steam, I am quite sure every person here present must be aware of the very great advantages of that source of power, that immense power we see daily before us; and if we look back to the days since James Watt lived, to the present time, everybody will be convinced of the great improvements that have taken place by the application of science to that particular element. I recollect well, in the early part of my own history, that the steam engine never worked above seven to eight pounds upon the square inch; it then reached twenty pounds, then fifty pounds. Now, in the locomotive engine, the pressure is one hundred and fifty pounds, and

even two hundred, upon the square inch. This is a great advantage, and if we may judge by the great improvements which are taking place with regard to the steam engine, the locomotive as well as the condensing engine, I am inclined to think that we are not by any means arrived at the full economy of the production of steam in this country and all other countries. Instead of working at the rate of two hundred pounds upon the square inch, I think it is very likely that it will reach five hundred pounds."

Mr. Gladstone, who followed Mr. Fairbairn in another speech, described this progress of railroad mechanism by another interesting illustration, which we give in his own language: — "I would recommend those who wish to measure practically the advancement in this department of mechanical science, to read the evidence which was given by the elder Mr. Stephenson before the first committee of the House of Commons, which was appointed to consider the first bill for the purpose of making a railway from Liverpool to Manchester. When that gentleman appeared as a witness in the face of able and learned men, whose business it was to convict him of being a mere dreamer and enthusiast, he judiciously avoided stating what, perhaps, his prophetic spirit had divined of the great results that were about to be achieved; and I think that when Mr. Stephenson was asked at what rate it was probable that the locomotive engine would carry passengers along that railway, he judiciously confined himself to the statement that he was sanguine enough to believe that such an engine would be able, under favorable circumstances, to draw those passengers at the rate of eight or ten miles an hour. But even that did not satisfy the relentless ingenuity of those who cross-examined him, and they solemnly adjured Mr. Stephenson to say whether, upon his credit as a man of practice and a man of science, he would undertake to assure that committee, that he thought that such an instrument as a steam engine ever would draw people along the iron rail with such velocity as the speed of eight or ten miles an hour. And Mr. Stephenson was so wise in his generation, that he would not adhere to the speed of eight or ten miles. I do not recollect the figure to which they brought him down, but I think at last he would not absolutely commit himself to promise a speed of more than five or six miles an hour. Mr. Harrison was the leading counsel against Mr. Stephenson. He was not satisfied with the modesty of that eminent man, and the prediction he had made. He ridiculed those predictions, and said: 'Woe be to the unfortunate gentleman, who, living in Liverpool or Manchester, and having an engagement to dine in the country at a particular hour, shall trust himself to one of our trains with the expectation that it will bring him in time for dinner.' Well, ladies and gentlemen, we have passed by that scene; and I believe I should be correct in saying that even since the locomotive began to display its powers in practice, — since the railway system was established, — those powers have been far more than doubled; and we do not know at what point the limit of their application may be reached."

BOILER EXPLOSIONS AND THEIR CAUSES.

The subject of boiler explosions has been discussed at great length during the past year in English scientific periodicals. In the London *Engineer* and London *Mechanics' Magazine*, editorial articles and contributions from correspondents have appeared weekly, in which various theories have been advanced, attacked, and defended; and the conflict still goes on. The discussion has excited our attention not only on account of its nature, but also because of the persons who have taken part in it, such as C. Wye Williams, the author of a valuable work on combustion; D. K. Clark, author of the incomparable work on locomotive engineering, and Zerah Colburn (now in London), an able American writer on railway engineering topics. Quite a number of others, whose names we omit, have also taken part in the discussion. There is still some apparent mystery connected with the phenomena of boiler explosions, or we would not have so many notions and theories floating about respecting their causes. The most common theory of boiler explosions is that of accumulated over-pressure of steam generated by the heat in the furnace. This theory embraces defects in the boiler, also the absence of a sufficient quantity of water, whereby the metal is permitted to become red hot and weak, and is capable of explaining most of the explosions which have occurred.

The theory of C. W. Williams is to the effect that steam is concentrated in the water under pressure in a steam boiler, like carbonic acid gas in soda water, and when it is relieved of pressure it suddenly assumes a violent expansive action.

The theory of D. K. Clark consists in considering the water in the boiler necessary to produce an explosion, by acting like a projectile with a bounding force against the metal.

Mr. Zerah Colburn's hypothesis consists in assuming that when water, heated with steam above atmospheric pressure, is suddenly relieved of pressure by a large rupture, a considerable amount of the water is instantly flashed, gunpowder-like, into steam.—*Scientific American.*

NOVEL ARRANGEMENT OF STEAM BOILERS.

At the meeting of the Society of Civil Engineers of Vienna, Austria, M. Strecker communicated a very ingenious and simple mode of preventing the burning of steam boilers. This apparatus, invented by M. J. Haswell, director of the Vienna Locomotive Factory, consists in introducing into the interior of the boiler a small turbine, which continually drives the water from the bottom towards the front of the boiler; thus on the one hand cooling the walls which are most liable to overheat, and on the other facilitating the formation of steam.

WORKING STEAM EXPANSIVELY.

During the winter of 1860–61, experiments were made, under order of the Secretary of the Navy, by a Board of Chief Engineers

of the Naval Engineer Corps, to determine certain questions in reference to the economy of steam expansion. Previous experiments made by the chief officer of the Board had induced him to assert the fallacy of the commonly received doctrine of economy in expansion, and these observations were undertaken to pursue the investigation on a more perfect engine, and with greater care. A report of the results has been published by the Navy Department, from which the following facts are derived: —

The vessel selected to test the relative merits of expansive and non-expansive steam in cylinders was the *Michigan*, a government paddle-wheel steamer lying at Erie, Pa. The larboard engine only was used, and it was employed in exerting its power to paddle the water aft while secured at the dock. Each experiment lasted seventy-two consecutive hours, during which the engine was neither stopped nor slowed down, nor in any way changed in condition. It was always operated several hours, so as to get the steam to the same pressure, the fires in proper order, and all things adjusted correctly, before each experiment was actually commenced. The water in the boiler was gauged, and the quantity fed in was accurately measured. Every pound of coal fed into the furnaces was carefully weighed; indicator cards were taken, and everything arranged to insure accuracy. The results of seven experiments, cutting off at $\frac{11}{12}$, $\frac{7}{10}$, $\frac{4}{9}$, $\frac{3}{10}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{4}{45}$ths of the stroke, are given in a tabulated form. Five of these were performed with Ormsby bituminous coal, and the other two with anthracite and Brookfield coal. The pressure in the boilers above the atmosphere was 195 lbs. the lowest, 22 lbs. the highest. The quantities of water consumed were 39.942 lbs. per total horse power, cutting off at $\frac{11}{12}$ stroke; 30.881, at $\frac{7}{10}$; 29.416, at $\frac{4}{9}$; 30.592, at $\frac{3}{10}$; 29.841, at $\frac{1}{4}$; 30.715, at $\frac{1}{6}$; 32.044, at $\frac{4}{45}$. These are important items, demanding careful scrutiny.

The water fed into the boiler was carefully measured in a tank, and it was found that just in proportion as expansion was extended, there was a proportionally greater loss of steam in the cylinder by condensation — a great deal more steam flowed into the cylinder than was accounted for by the indicator. Thus, cutting off at $\frac{11}{12}$ of the stroke, the loss was 2.91; at $\frac{7}{10}$, 6.60; at $\frac{4}{9}$, 18.14; at $\frac{3}{10}$, 33.07; at $\frac{1}{4}$, 30.84; at $\frac{1}{6}$, 33.66, and at $\frac{4}{45}$, not less than 37.16 per cent. not accounted for. In short, the conclusions from these experiments are, that so much condensation takes place in the cylinder by the cooling action of expansion, that no economy results from using highly expanded steam. It is true that somewhat more power is developed in the same cylinder by expansion, but by using smaller cylinders, proportioned to the power required without expansion, the economy is on the side of non-expansion, both with respect to fuel and the cost of machinery. These conclusions, it must be evident, are of a very radical and revolutionary character, inasmuch as they affect principles which have been accepted in practice from a very early period in the history of the steam engine applied to actual work. They differ from the whole tenor of experimental observations and theoretical deductions, and, if accepted by the profession, would modify at once our proportions of working parts, and our applications of power. But it should be also stated, that these conclusions are not universally ac-

cepted, and, indeed, are considered by some high authorities as based on faulty and incorrect experimentation.

SUPERHEATED STEAM.

Much has been written within the last few years relative to the above topic, and there can be no doubt that, if superheated steam is properly used, a saving of fuel may be effected. Many of the statements published, however, have made the success too great. Some time since the English Pacific mail steamers had their engines arranged to use highly superheated steam (450 to 500 degrees), and for a while the change was regarded as beneficial. It is now, however, found that this high heat is very destructive to the engines, injuring the cylinders, pistons, valve faces, and valves; and so great has the injury been, that they have commenced to take out and much reduce the number of superheating tubes.

COAL AND WOOD-BURNING LOCOMOTIVES.

By a late report of John O. Sterns, Esq., superintendent of the New Jersey Central Railroad, we learn that very fair tests have been made with wood and coal-burning engines on that road, all of which have terminated favorably for coal, as it regards economy. There are thirty-eight locomotives, six of which have been altered from wood to bituminous coal-burners; twenty-four burn wood, and eight anthracite coal.

During the last two years and nine months, the wood-burning engines have run 1,353,909 miles, the anthracite coal engines 165,585, and the bituminous engines 112,757 miles. Regarding the performance of these three classes of engines, Mr. Sterns says: — "The three comparatively perfect anthracite engines make a saving in fuel of seven cents per mile over three equally good wood engines, and the difference in cost for repairs cannot exceed three cents per mile, leaving a net saving of four cents per mile run by substituting anthracite coal for wood. . . . From our past experience, I am satisfied there is a saving by using bituminous coal instead of wood, of about three cents per mile, and that it is expedient to alter several of our wood-burning freight engines to burn bituminous coal, especially as the change is easily and cheaply made."

The wood used by this company is oak, rated at five dollars per cord; the bituminous coal is the same cost per ton, while the anthracite is set down at three dollars per ton. The wood-burning engines run at the rate of 28.3 miles per cord; three good anthracite coal engines average 31 miles to a ton of coal. Mr. Sterns states that if all the freight trains on the New Jersey Central Railroad had been drawn by good anthracite coal engines, twenty thousand dollars would have been saved to the company last year alone. Where wood is very cheap, as in Canada and on some of the Southern railroads, of course it is preferable to use it; but wherever it can be shown that coal is cheaper than wood on any railroad, those who have the management of affairs are culpable if they run wood-burning engines. — *Scientific American.*

NEW MODE OF WARMING RAILROAD CARS.

Experiments with a new system of heating railroad cars have been instituted by M. Delcambre, in various parts of France, and have been recently repeated on the Paris and Montargis section of the Lyons line. By this plan, the steam which escapes from the locomotive is carried by a caoutchouc pipe to the first carriage, and there made to pass through conduits of copper, placed in the roof and the floor, to the end of the vehicle, where it is received into another flexible pipe, and carried on to the next carriage, and so on from one vehicle to another to the end of the train, where it escapes. The fixing and removing of the caoutchouc pipes is accomplished with the greatest facility, and the passage of the steam through the conduits presents no inconvenience to the passengers. By means of the new plan a temperature of 59° Fahrenheit was obtained on an excessively cold day, and at a merely nominal expense.

LOCOMOTIVES ON COMMON ROADS.

In anticipation of the adoption and use of locomotives on common roads, to the perfection of which considerable attention has been of late paid in England, a bill has been introduced into Parliament for their regulation. It exacts that the weight on each pair of wheels is not to exceed one ton and a half. The use of locomotives destructive to highways or dangerous to the public is to be prohibited by the Secretary of State, so as to prevent the excessive wear and tear. The weight of locomotives over county, parish, or suspension bridges is not to exceed fifteen tons, and any damage is to be made good. The locomotives are to consume their own smoke. Two persons are to drive and conduct every locomotive, and red lights are to be fixed conspicuously in front of locomotives and wagons one hour after sunset till one hour before sunrise. The speed of locomotives on highways is not to exceed ten miles an hour, and through towns, cities, or villages, five. No locomotive is to be used within the city of London more than seven feet in width and with wheels six inches wide.

MILITARY ARCHITECTURE OF THE MIDDLE AGES.

The above is the title of a work recently published in France, by M. Viollet-le-Duc, and translated into English by Mr. MacDermott. We derive from its pages the following items of information.

There are two great eras in military architecture: the first being the result of the Crusades, when the passive system of defence was superseded by an activity equal to that required for an attack; and the second being that marked by the introduction of gunpowder. The commencement of the latter era was the starting-point from which the subject has gradually been divested of everything like picturesque effect, till it has resolved itself, in the aspect of its fabrics, into the terrible uniformity and ugliness recognized by the term barrack style. In so far as a revival of pictorial results might be beneficial, the essay, with its telling illustrations, may be of service;

but, *au reste*, the days of castle-building are departed. Castles were essentially a feature of feudalism, and it would be meaningless to revive them. Nevertheless, it is interesting to trace in the compass of a few pages the successive steps made by generations of men, through centuries of time, towards the protection of their possessions or the acquisition of new territory. Until the middle of the fourteenth century, the defence was stronger than the attack, the balance of power, in the absence of gunpowder, being in favor of the massiveness of the architecture. Thus, in Norman times, the defence relied mainly upon its passive force, — the height of the walls defying all attempts at escalade, the strength of the gates resisting all efforts at forcing them. But towards the end of the fourteenth century, the attack became superior to the defence, and so it has remained, the converging fire of besiegers having advantage over the diverging fire of the besieged. Not only this, but the whole scheme of warfare has been altered by the application of modern appliances. In old times, the attack and defence were subdivided into parts, and thence into parts again; each tower of a castle being a separate fort, and again each story of that tower capable of separate and strong defence; so that the action took place on sites crowded with infinity of unexpected contrivances, and depended in great measure upon individual prowess. The use of gunpowder demanded a wider range, an enlarged field of operations, and united action. The futility of the axiom that *whatever defends should be defended*, was perceived by Machiavelli, who laid down as a primary rule the inadvisability of any complexity of the kind in the construction of fortresses.

M. Viollet-le-Duc has chosen for especial illustration the Chateau Gaillard, the fortress built by Richard Cœur de Lion on the Seine for the protection of the capital of his Norman territory, — Rouen. With all due deference to the French architect and antiquary, this must be considered as essentially an English castle as that of Newcastle-upon-Tyne. The details, which are amply illustrated, prove that the lion-hearted monarch was a most skilful architect, engineer, and master of defence. This is one of the new lights by which to read history, for which we should express ourselves indebted to M. Viollet-le-Duc. The castle was built under the immediate superintendence of Richard, and, with all its subtle contrivances and defences, was completed in a twelvemonth; when he is said thus to have apostrophized it: — "Qu'elle est belle, ma fille d'un an!" The outworks were so extensive that a town, known as Petit Andeley, arose within their enclosure. The *enceinte* of the principal portion of the castle presents a variety to the usual mode of building prevalent, which must be ascribed to the genius of Richard. It consisted of massive masonry arranged in a succession of segments of a circle, connected by a series of short curtains of an even length. The keep also differed from the common type. It was a mighty tower, strengthened by a girth of reversed pyramids, through the broad bases of which, on a level with the summit of the tower, were machicolations for close defence; and these were surmounted with a crenellated parapet, which was pierced with loop-holes. Notwithstanding the immense strength of this fortress, it fell before the skill of the

warlike Philip Augustus only a few years after the death of Richard.

The timber galleries (*hourds*), which were thrown out on the crests of curtains and towers when in a state of siege, occupy a full meed of attention. These appear to have been too little considered by archæologists when examining the remains of castellated buildings. When attack was anticipated, the defenders strengthened their position by erecting galleries whence they could command the bases of the curtain walls and exterior towers, which they would otherwise only have been enabled to protect so far as they were flanked by towers; and, as the operations of the enemy, both by mines and cats (*chats*, *gats*, *gates*) and battering-rams (*moutons*, *bossons*), were directed to these, it will be seen how important their defence became. This accession to the means of defence was as common to the English castles as to the French. Froissart, the French historian, who, from his five years' service with the queen of our Edward III., as secretary, would probably depict as an eye-witness, has left among his MSS. a vignette showing that the castle of Newcastle possessed these *hourds*. In times of peace they were removed. They overhung on both sides of the curtain, forming an inner as well as outer gallery. At first the supports upon which they rested were of timber likewise; subsequently they were supported on corbels of stone, as at Coucy; and ultimately they were succeeded by overhanging stone parapets (*chemins de ronde*) resting on corbels trebly or polygonally notched. There are numerous instances of overhanging stone parapets to English gateways and towers, the Edwardian castles making free use of this effective mode of construction. Windsor, Morpeth, Conway, Warkworth, Brancepeth, the Pele Towers of Northumberland, are specimens in question.

M. Le Duc shows an intimate acquaintance with the various engines of war, and with skill depicts every particular of a siege. In the *Dictionnaire Raisonné de l'Architecture* these subjects are treated at still greater length; and it is to be regretted that all instead of part of the illustrations pertaining to this branch of the subject were not inserted in the present volume. Engineers (*ingegneors*) were specially appointed for the construction of military engines as early as the end of the twelfth century. There was the moving wooden tower, which, running on rollers, could be propelled up to the castle walls, and which, being furnished with a movable bridge, permitted the besiegers to land on the parapets; then there was the movable colored platform called the cat (the Roman *musculus*, rat), which afforded cover to the assailants when they wanted to undermine the towers or curtains with pickaxes or fill up the moat with earth or stones; further, there were the battering-rams and the catapults (*trébuchets*), *mangonels*, *calabres*, and *pierriers*, all of which were worked by counterpoise, and possessed accuracy of aim, to the prevention of the besieged from keeping upon their walls. During the formation and putting into position of these several engines the workers were protected by palisades, *brattishes*, and movable mantelets (wooden screens). The wooden turrets, the cats, and other machines were covered with raw ox and horse hides, to prevent them from catching fire, as the besieged used their utmost endeavors to

set them alight, sewing up, in cloths, fire, sulphur, and flax, which they let down the walls by chains with the double purpose of blinding and suffocating the assailants as well as destroying their engines. When the walls were reached by means of mines, the besiegers smeared the timbers with which they propped the walls during the process of sapping with pitch and vast quantities of bacon fat. When they had accomplished their task they retreated, setting fire to this inflammable mixture. In fine, the energy with which the rude materials at command were used, and the invention bestowed upon their application to destructive purposes, are lessons which the most imposing of our guardsmen might study with profit. Water as well as fire was largely taken into account as an assistant in defence.

The immense number of castles, both in England and France, is very remarkable. The French castles may be said to have accommodated the whole French army; not so the English. The English monarchs possessed an organized army of archers, which they could command independently of any assistance from their nobles. This is the reason why the French always lost and the English always won. The French nobles feared to trust the lower classes with weapons, feeling that their numerical strength was so considerable, that, if once trained to act in combination, their own power would be held in check. Their sovereign, therefore, relied entirely upon them for his army, with the exception of hired troops of Genoese or Brabançon archers. The nobles responded to his call with their retainers, *bidauds*, *valets*, and brigands, forming a rabble rather than a regular force; and, as at the first reverse the hired archers took the opportunity to plunder and return to their homes, these had to bear the brunt of the battle. It is scarcely surprising, therefore, that the châteaux were of an extent beyond that required for the *vie privée de la noblesse féodale.* This extent begat immense power on the part of the owners.

TESTING OF THE TUBES OF THE VICTORIA BRIDGE.

Mr. Chas. Legge, C. E., of England, in a recent pamphlet entitled *A Glance at the Victoria Bridge*, gives the following interesting account of the manner in which the great tubes were tested, and of his personal experience in connection with the experiment:—

On the 15th of December, preparations were completed for a final test of the strength of the tubes; singularly enough at the same time with the close of navigation, when vast fields of ice, under nature's superintendence, were hurling their solid masses against the masonry of the piers and testing their efficiency and strength by over one million tons a minute. Any force or weight man could bring into comparison with this would be puny in the extreme. Yet, notwithstanding the inability of competing with nature's test, a load had been obtained such as seldom before was seen for a like purpose. A train of platform cars five hundred and twenty feet in length, extending over two tubes, was loaded, almost to the breaking limit of the cars, with large blocks of stone, and in readiness for the experiment. Prior to this a steel wire was extended the entire length of the tubes for the purpose of measuring the deflection, and strained by heavy weights

as tightly as possible over pulleys at every bearing of the tube. This wire formed the datum from which all movements were to be measured on slips of card attached to vertical staves at various points along the tube.

During the two days occupied with the test the public were rigorously excluded. At each slip of paper one of his assistants was placed, and provided with a lamp and a pencil, by which to make the necessary marks. The loaded train was then taken hold of by two of the most powerful engines belonging to the Grand Trunk, and, with extreme difficulty from the great weight, brought into the first two tubes, beyond which all their united efforts failed to draw it. A third engine having been obtained, the three were barely able to force the load along to the centre of the bridge; when night coming on, the test of the remaining portion of the bridge was deferred until the following day.

Early next morning, the interesting experiment was resumed, and concluded during the day.

In giving the result of the fearful ordeal to which the tubes were subjected, we will only note the deflection on a pair of the side tubes the others being similar, and the central one.

When the train covered the first tube, the deflection in the centre amounted to seven-eighths of an inch, and the adjoining one, to which it was coupled, was lifted in the middle three-eighths of an inch. The load then being placed over both tubes, the deflection was the same in each, or three-fourths of an inch in the middle; and on being entirely removed, both tubes resumed their original level. The large centre span, entirely disconnected from the other tubes, on being covered with the load throughout its entire length, deflected in the centre only one inch and seven-eighths, and came back to its previous level on the load being removed.

All these results were considered highly satisfactory, as being considerably within the calculated deflection for such a load according to formulæ well known and generally made use of.

Nothing exemplified more strongly the confidence felt by Mr. Hodges in the strength of the work than the severe test to which he exposed it. The writer well remembers the "peculiar feelings" he experienced when standing at the marking-post assigned him, surrounded at the same time by an Egyptian darkness, dense enough to be felt, arising from the condensed steam and the smoke of the engines, and totally obscuring the light of a glass lamp two feet distant. To thus stand closely pressed up against the side of the tube, with eyes and lamp brought within a few inches of the datum-line, intently watching its movements, and leaving but sufficient room for the slipping, groaning, puffing, but invisible engines and their heavily-loaded cars to pass, with but a quarter of an inch of boiler-plate between time and eternity; or, when mentally reasoned back to safety and security, and while listening, during the stoppage of the train, to the surging, cracking, crashing ice far below, as it swept past, to have those feelings of personal security dissipated in a moment by the thought of an over-loaded car breaking down and burying the deflection-observer beneath its weight, was surely reason enough for the existence of the "peculiar feelings" alluded to.

DURABILITY OF WROUGHT IRON WHEN USED FOR STRUCTURAL PURPOSES.

Mr. John A. Roebling, the engineer of the Railway Suspension Bridge spanning the great gorge below the Falls of Niagara, in a recent report to the directors of the bridge company, on the condition of the bridge, after five years' continuous use, thus discusses the important subject of the durability of wrought iron, when used for structural purposes. His remarks will be found by our readers to embody a great amount of useful and interesting information. — *Ed.*

The fact is well known, that wrought iron, under certain conditions, will undergo certain radical changes. And so will all kinds of matter, — material existence being but a theatre of change, breaking down, of reduction, and of reconstruction of the elements of matter. And as all human fabrics, being but material constructions, will have to succumb to the same inexorable law, we cannot expect that the Niagara Bridge will form an exception.

Two kinds of changes are known, which will affect the strength of iron and other metals. The one is wrought by the chemical process of oxidation, and can be guarded against effectually, and is so guarded in the Niagara Bridge. All iron and wire within reach are kept well painted, and thus preserved against rust. The anchor-chains and their connections with the cables, inside of the anchor-masonry and in the rock below, after three coats of paint, are protected by the cement grout, which forms a solid envelope, excluding air and moisture.

But, aside from the mechanical protection thus afforded, I depend principally upon the well-known chemical action of calcareous cements in contact with iron. Oxygen has a greater affinity for lime than for iron. So long, therefore, as the cement will combine with oxygen, or, in other words, has not become completely crystallized, which is a very slow process inside of heavy masonry, the iron will be protected. The cement, not exposed to the air, when setting slowly, has a tendency rather to expand than to contract: but suppose there should be cracks around the anchor-bars large enough to admit air and moisture, water will then find its way through those cracks, but, on reaching the iron, will be more or less impregnated with cement, and thus add another protecting coat. The chemical principle, which I have explained here, I apply daily in my factory for the preservation of wire against dampness. I have also carried on direct experiments for a number of years, which have convinced me of the preserving property of calcareous cements in damp situations.

On examining recently the anchor-bars of the Monongahela Suspension Bridge at Pittsburgh, built sixteen years ago, I found them perfectly preserved, as far as the cement, in which they are embedded, was removed.

But iron, under certain conditions, will undergo another change, which is not so well understood, and is indeed, as yet, a partial mystery. And this fact has been seized upon as an invincible argument against iron bridges generally, and against the Niagara Bridge

especially. I refer to the supposed and popularly so-called *granulation* of fibrous wrought iron.

Although this subject has engaged my attention for a series of years, and I have taken pains to obtain correct information, I yet hesitate to express any decided opinions, that would cover the whole field of investigation. The question at large I consider open yet. This much only I believe to be settled, that good iron will undergo no change in course of time, unless it is acted on by great heat, or is under the influence of strong continuous vibrations under tension.

As an exception to this last proposition, may be cited the case of old anchors and chains, which, after being exposed on the ground or in the ground a great length of time, had become considerably rusted and reduced in strength. Aside from rusting, magnetic influences were supposed to have been at work in destroying the strength of these irons. But it should be remarked, that none of these have been sufficiently well examined to warrant sound conclusions. It is true that the earth forms a great magnet, whose magnetism is maintained by the sun; and that the magnetic condition of all metals is more or less depending upon the great parent magnet. A steel magnet that has lost its power or tension, when buried in the earth, will be restored by its magnetic currents. But how far the cohesion and elasticity of wrought iron may be affected by these currents, we are yet ignorant of. When a bar of iron is drawn apart by a tensile strain, the fractured ends are magnetically excited and will attract iron filings, at the same time that they become heated. Both phenomena, magnetism as well as heat, will always accompany the forcible rupture of iron, as can be readily ascertained by experiment. The same phenomena are also exhibited when iron is hammered cold, the heat in this case being more apparent than the magnetism.

The cohesion and elasticity of wrought iron, although different properties, appear to be closely related. In speaking of elasticity, I mean the natural elasticity, and not what is produced by the forced process of tempering. And here may be pointed out a marked physical difference between steel and iron. While the hardening or tempering of steel can be carried to almost any degree, that of the latter cannot.

Whatever destroys or impairs the elasticity of iron or steel will also affect its cohesion. And this fact has also a significant magnetic bearing. Tempered or hardened steel possesses more tensile strength than soft steel. Now, when tempered steel loses its hardness by annealing, it assimilates nearer to soft iron in its relation to magnetism. Red-hot iron is not attracted by a magnet, while a steel magnet entirely loses its magnetic properties on being heated red-hot. Another remarkable fact is, that artificial as well as natural magnets, when *overloaded*, become weakened. And so does the cohesion and elasticity of an iron or steel bar become weakened by overloading.

The limit of elasticity, or of the *recuperating* force, as it might be termed, of iron and steel is generally stated at one-third of their ultimate strength. I am of the opinion that this is much *over*-estimated for soft puddled irons, and *under*-estimated for good hammered charcoal irons, and still more for steel.

The force which holds together the molecules of iron is termed cohesion. Teat will expand iron, and, when applied intensely and continuously, will melt it, and will thus destroy all cohesion, and at the same time all elasticity and all magnetic tension. It follows, then, that heat of a certain degree is opposed to cohesion and elasticity. And this explains why large masses of wrought iron, when being forged, and thus subjected for a considerable length of time to an annealing process, will, in the centre, become greatly reduced in cohesion and elasticity. The previously existing fibre in the faggots will change into a coarse crystalline texture, because the iron being in a pasty and nearly molten state, and the mechanical effect of hammering being confined to the surface, and not penetrating to the centre, the formation of large crystals will be left undisturbed. Broken car-axles sometimes appear to have undergone a similar change. The fact is that they generally exhibit a crystalline fracture. But I suspect that many new axles, although manufactured out of fibrous rough-bar, will, when finished and broken *before* they are used, also exhibit a crystalline fracture. In my own practice I have witnessed the fact, that an experienced manufacturer, anxious to satisfy me, did not succeed in manufacturing round bolt of four to five inches diameter out of good fibrous rough-bar, without producing a crystalline texture in the centre. The oftener he piled the iron, the worse the result. On the other hand, I never heard of a failure when the bolt was forged entire under the hammer out of good and well-worked and thoroughly-hammered charcoal blooms, their rough ends cut off.

The most fibrous bar iron may be broken so as to present a granular and somewhat crystalline fracture, and this without undergoing any molecular change in the texture. Take a fibrous bar, say ten feet long, but the longer the better, nip it in the centre all around with a cold chisel, then poise the bar upon the short edge of a large anvil, and a short piece of iron, placed eight or nine inches from the edge on the face of the anvil, then strike a few heavy blows upon the nip, so that each blow will cause the bar to rebound and to vibrate intensely, and the result will be a granular and somewhat crystalline fracture. Now take up the two halves, and nip them again all around, about one or two inches off the fractured ends, break them off by easy blows over the *round* edge of the anvil, and the fibre will appear again. This experiment proves that a break, caused by sudden jars and intense vibration, may show a granular and even crystalline fracture, without having changed the molecular arrangement of the iron. All fibres are composed of mineral crystals, drawn out and elongated or flattened; and the fracture may be produced so as to exhibit in the same bar, and within the same inch of bar, either more fibre or more crystal. But a coarse crystalline bar will, under no circumstances, exhibit fibre; nor will a well worked out fibre exhibit coarse crystals.

My own view of the matter is, that a molecular change, or so called *granulation* or *crystallization*, in consequence of vibration or tension, or both combined, has in no instance been satisfactorily proved or demonstrated by experiments.

I further insist that crystallization in iron or any other metal *can never take place in a cold state.* To form crystals at all, the metal must be in a highly-heated or nearly a molten state.

On the other hand, I am witnessing the fact daily, that vibration and tension combined will greatly affect the strength of iron *without* changing its fibrous texture. The cohesion and elasticity of wire and wire rope will be rapidly destroyed by great tension and vibration combined. Whether I shall be able to account for it or not, *there stands the fact.* But what is true of iron wire applies with equal force, and, when all circumstances and conditions are duly proportioned, with even greater force, to larger masses. The extensive opportunities which my pursuits offer to make experiments and observations on wire and wire rope, authorize a positive expression on this subject. A great deal of fancy speculation has been indulged in of late years on this question of granulation and crystallization, but generally by men whose opinion can have no weight.

Now, while the fact remains that iron and steel will lose their strength by vibration and tension, it is proper to state, also, in this connection, that this loss of strength bears a due proportion to the extent and duration of the vibration and tension. Wire ropes may lose their strength by three months' service, *without* exhibiting much wear; and they may also last ten years, running all the time, and be greatly worn, before their strength is so far reduced as to be unfit to do duty. I will state here, that there are now ropes of my manufacture on the inclines of the Morris Canal, which have run nine years. This great durability is owing to comparative absence of vibration, in consequence of slow speed and good machinery, although a high tension is maintained.

The greater the elasticity and cohesion of the iron or steel, the better it will support vibration and tension, always provided that the extent of this vibration and the amount of tension are kept within safe limits. Witness, as examples, the durability of watch springs, piano wire, sofa and wagon springs, etc. etc.

Wrought iron that has become brittle, as, for instance, chain, car-axles, wire or wire rope, on being annealed, will have its softness and apparently also its strength restored. As far as softness is concerned, this is correct; but in regard to strength, when applied to wire or wire rope or to fine chains, it is a mistake. Soft annealed wire possesses only half the strength which hard wire has, and is without any elasticity. But wire rope without elasticity is worthless; very little work will make it brittle again and worse than before. It is different with heavy chains and with car-axles. Made of indifferent material, crystalline or brittle when new, they will be greatly improved by an annealing process at the very beginning; and if this process is repeated from time to time, their lifetime may be prolonged. I maintain that a good car-axle, made of good material, and finished at the proper heat, by hammering or rolling, is stiffer and stronger than the same axle, when again subjected to annealing without hammering or rolling. Annealing restores softness, but at the same time reduces cohesion and elasticity. To restore the iron of a brittle car-axle fully, can only be done by a full heat, with hammering or rolling, which of course will reduce its diameter.

The opinion prevails, that a well drawn out fibre is the only sure sign of tensile strength. This, however, is true only when applied to *ordinary* qualities of bar or rail iron. The fact is different with

good charcoal irons and with steel. The greatest cohesion is accompanied by a fine, close-grained, uniform appearance of texture, which, under a magnifying glass, exhibits fibre. The color is a silvery lustre, free from dark specks. The finer and more close-grained the texture, the nearer the iron approaches to steel. Those who are familiar with good Swedish or Norway irons will support these statements. These facts alone should be sufficient to disprove the erroneous notion that good iron and steel, which should always be granular, will become so only by vibration, and will thereby lose their strength. But it is important to keep in mind the distinction between a fine, uniform, granular fracture, and a coarse crystalline fracture. Where coarse crystallization appears, there is a want of contact and compactness, consequently of cohesion and strength generally.

Wire cables, car-axles, piston-rods, connecting rods, and all such pieces of machinery, which are exposed to great tension as well as torsion and vibration, should be manufactured of iron which not only possesses great cohesion, but also a high degree of hardness and elasticity. The best car-axles now in use are those made of soft steel by Krupf, in Germany. This steel is manufactured from the spathic ore, or natural steel ore, of the celebrated mines at Muessen in Siegen, Prussia. A correct report on these axles was given to me by one of the Prussian commissioners of railways, in whose district Krupf's works are located. They are safe in cold weather, and seldom known to break. This proves that soft steel with more of a granular texture than fibre possesses a much greater elasticity and strength than the best fibrous iron; and it also furnishes another strong proof against the granulation theory, so much credited in this country.

It may be objected that steel is a different metal from iron. But all irons and steels are only so many different alloys of the same metal. There is no essential difference between the two. What constitutes the true chemical and physical difference between the two varieties is not so clear.

The capacity of irons to resist vibration and tension differs much in different qualities, and still greater is this difference when the irons are exposed to a very cold temperature. The tubular bridge at Montreal will not last as long as one in Great Britain of the same dimensions, material, and workmanship, and rendering the same service; and still less than the tubes over the Nile, in Egypt. One hard winter in Canada will be as trying to the structure as ten years are in Great Britain.

In order to examine the fitness of various qualities of iron for the manufacture of wire rope, I undertook, during the hard winter of 1856, at my establishment at Trenton, a series of experiments, when the thermometer was five to ten degrees below zero. The samples for testing, about one foot long, were reduced in the centre to exactly three-quarters of an inch square, and their ends, left larger, were welded to heavy eyes, making in all a bar of three feet long. Thus prepared, they were thrown outside of the mill, covered with snow and ice, and left exposed for several days and nights. Early in the morning, before the air grew warmer, a sample, inclosed in ice, would be put in the testing machine, and at once subjected to a strain of

26,000 lbs., the bar being suspended in a vertical position, left free all around. A stout mill-hand, armed with a billet of one and a half inches in diameter and two feet long, then struck the sample horizontally a number of blows, hitting the reduced section as hard as he could. The blows were counted and continued until rupture took place. Care was taken to maintain a tension of 26,000 lbs. during this test, by screwing up the lever, while the sample kept stretching. Other means for producing vibration were attempted, but none proved so effective as the hitting with an iron bolt. I would remark here, that most of these irons would support from 70,000 to 80,000 lbs. per square inch; and that good samples of three-quarters of an inch square would support a strain of 26,000 lbs. for a whole week, with no visible stretching, provided all vibration and jarring was avoided. But the least jar would produce a permanent elongation.

Without going into the details of these interesting and instructive experiments, I will only state that the number of blows which the different samples resisted, when encased in ice, ranged from three to one hundred and twenty. Inferior qualities of a crystalline texture would break at the third or fourth blow. Good samples of refined puddled bar resisted very well, and went up to sixty blows, while the better qualities of hammered charcoal irons supported up to one hundred and twenty blows, stretching and drawing all the time. Indeed, it seemed a wire-drawing process on a rough scale. On the tension being reduced to 20,000 lbs., some good samples resisted the almost incredible number of three hundred blows before breaking.

Such qualities of iron may be depended upon for the construction of wire cables and car-axles. They will be safe at the North Pole, while inferior qualities may answer very well in warmer latitudes.

Well observed facts of the durability of irons, when exposed to tension and vibration, are of more value than speculative opinions. I will here record a few more facts, experienced by myself.

In 1844 I removed the old timber aqueduct over the Alleghany River at Pittsburgh, the heaviest work of that description in the United States, consisting of seven spans of one hundred and fifty feet reach. It had stood fourteen years. All the suspension bars taken out of the old trusses and arches, and originally made of good puddled iron, on being tested and worked up into bolts for the new wire suspension aqueduct, proved of good quality, — as good as such irons generally are.

During the great fire at Pittsburgh, in 1845, the old Monongahela Bridge, of eight spans, a heavy Burr structure, burned down. I contracted to put up a suspension bridge, and accepted all the old materials, which were not consumed, including about thirty tons of hammered charcoal iron of excellent quality. This iron, after a severe usage for over thirty years, was found so good that I had it all drawn into wire. Every bar was good for 60,000 lbs. per square inch, as strong and tough as it ever could have been before going into the bridge. The old structure was loose and limber, producing considerable vibration on all vertical bars.

On excavating for the southern anchorage between the old wing-walls of the old Monongahela Bridge, a number of round bars of one and a quarter inches diameter, about forty feet long, good puddled

fibrous iron, were taken up. They had served as tie bars to keep the retaining walls from spreading. Screwed up tight, they had been under ground about twenty-five years, embedded in clay. The outside rust, firmly combined with clay and sand, appeared to have formed a protective coat. At any rate, the strength of the iron had not suffered at all from oxidation; its quality was as good as any puddled bar manufactured at the present day.

Last year, while removing the old St. Clair Street Bridge over the Alleghany River at Pittsburgh, to make room for a new suspension bridge, since completed, I examined the old iron with considerable interest and care. All this iron had been manufactured about forty-one years ago, and had been the result of the first attempt at puddling ever made west of the Alleghany Mountains. The manufacturer, who is still living, informed me that in those days puddling was not well understood, and that, although the stock was good cold-blast charcoal pig, the iron turned out a highly crystalline texture. It proved so on its fracture, but of a good color; the texture was uniform and not coarse. On being heated and drawn down to half its size, it made a strong fibrous iron; all it wanted was work. There was not one fibrous bar in the whole lot of suspension bars; they were all alike crystalline and brittle in texture. This iron had, from the manufacturer's own testimony, undergone no change; it was as crystalline on the last day as it was on the first. But there was another quality of iron in the same structure. The straps and bolts which connected the chords with the posts and braces had been manufactured of a good quality of hammered charcoal iron, and a most capital iron it proved, after forty years' service.

All irons form alloys of pure iron, mixed with carbon and other impurities. A certain amount of impurities in the shape of good cinder appears to be necessary to impart strength and cohesion to this metal, and also to make it malleable, and to give it welding properties. The purer the iron is, the higher the heat at which it will weld. Compare, for instance, good Swedish iron with common puddled bar. While the latter will weld at a low heat, the former requires a much higher heat. Compare their fracture and color. The good Swedish bar will exhibit either a fine granular appearance or fibre, accompanied by a silvery lustre, showing comparative purity; the puddled bar will be of a dark color, with a graphite lustre, and will show a coarse texture or loose fibre.

During the process of puddling, as well as of blooming, the melted pig-iron is mixed with cinder, and this mixture, which will adhere by cohesion, prevents the formation of large crystals, which is the tendency of pure iron in a molten state. Now by working (bringing to *nature*, as the puddler calls it), this mixing and crystallization is promoted. The subsequent squeezing and rolling of the puddled ball, or the hammering and shingling of the bloom, will have the effect of condensing, laminating, reducing, and drawing out these crystals, at the same time removing and squeezing out the superabundant cinder from between the metallic crystals. Thus the drawn-out fibre is composed of an aggregate of pure iron threads and leaves, enveloped in cinder.

Pure iron, as well as very impure iron, is weak; the maximum

strength and toughness is obtained by a certain mixture of pure iron with carbon and cinder, thoroughly worked and incorporated. When the fibrous and laminar aggregation becomes so dense as to be fit for the manufacture of steel, then are by this very process sufficient impurities expelled, and the greatest degree of cohesion is obtained. Hence strong steel can only be made of strong iron, no matter what chemicals may be administered during the process.

Keeping the above process before our mind, we may now understand why even the best fibrous wrought iron, when exposed to long-continued vibration under tension, or to torsion, bending or twisting, must inevitably become brittle, *because the iron threads and laminæ become loosened in their cinder envelopes.* But the cohesion between the iron and its cinder once destroyed, and its strength is gone. Now whether cohesion is the result of magnetic attraction (according to Faraday) or otherwise, this process appears to be purely mechanical. But let the explanation, which is here offered, be correct or not, the fact remains that fibrous iron, and all kinds of iron and steel, will be rendered brittle by vibration and tension, or by bending and twisting, *without* undergoing any mysterious change in its molecular arrangement.

It is only within the last one hundred years that wrought iron has become a *necessity* on public and private works. Large structures entirely composed of iron are of a still more recent date. Long experience on a large scale is therefore wanting. But, as far as it goes, the opinion is fully sustained, that good iron, not overtaxed by tension and vibration, and otherwise preserved, will prove one of the most durable building materials at our disposal.

The Menai Chain Suspension Bridge has now stood about thirty-six years, and is still considered a safe work, although it has, for the want of stiffness, on several occasions suffered severely from gales. The old wire Suspension Bridge at Friburg, in Switzerland, has been in use about twenty-seven years, but it does not possess enough of strength and stiffness to guarantee its safety much longer in its present state.

It should be remembered that there are many suspension bridges in this country, as well as in Europe, built without any regard to stiffness, and are therefore constantly subjected to vibration, which must greatly limit their durability.

The cables of the Niagara Bridge, on the other hand, are free from vibration, consequently will last as long as the nature of good wrought iron will permit, when subjected to a moderate tension, not exceeding one-fifth of its ultimate strength. This durability I am unwilling to estimate at less than several hundred years.

EFFECTS OF VIBRATORY ACTION AND LONG-CONTINUED CHANGES OF LOAD UPON WROUGHT-IRON BRIDGES AND GIRDERS.

Mr. Fairbairn, in presenting a paper with the above title to the last (1861) meeting of the British Association, said that the subject was one of great importance as affecting the construction of tubular

and plate bridges, and also the lattice and trellis bridges. Fifteen years ago experiments were made which led to the construction of the Conway and Britannia tubular bridges on the Chester and Holyhead Railway, and determined the form in which such structures should be designed. Since that time some thousands of bridges had been built entirely of iron. The requirement of five tons per square inch on the part of the British Board of Trade appeared to be founded on no fixed principle. It was well known that the power of resistance to strain of wrought iron depends very much upon the form in which it is combined, and unless the proportions of the parts were permanently established, the five-ton tensile strain might lead to error. For the purpose of making experiments upon the influence of vibration in causing the rupture of beams and bridges, he had constructed a small iron-plate beam of twenty feet clear span, and sixteen feet deep, representing the proportion of one of the girders of the Spey Bridge, and exposed it to conditions similar to those of a bridge subject to changes of load as produced by the passage of trains, and in proportion to the heaviest rolling load. The beam was first loaded to one-fourth of its breaking weight, and it sustained a million changes of load without injury. The load was then increased to nearly one-half the breaking weight. With this weight the beam gave way after 5,175 changes. It appeared, therefore, it was not safe to build bridges in which the rolling load would bear this proportion to the breaking weight. The beam was taken down and repaired, and the experiments were then renewed. The load was then reduced to two-fifths the breaking weight, and 25,900 changes of load were sustained. Lastly, the load was reduced to one-third, and the experiments were still proceeding, the beam being uninjured after 2,727,754 changes. In calculating the strain upon the area of the metal after deducting the rivet-holes, which, it must be remembered, were larger in proportion in this small beam than in bridges, he found that the beam would sustain no deterioration with strains of nearly seven and a half tons to the square inch. With ten tons to the square inch the beam broke after 5,172 changes. Now, as the limit of elasticity was reached at about nine tons per square inch in ordinary boiler-plates and bridge-plates, it would appear that it was unsafe to load structures subject to a continually varying load beyond that point. Within those limits, however, there was no evidence that a deterioration of structure took place. For the present, he would advise that in all beams and girders, tubular or plain, the permanent load or weight of the girder and its platform should not, in any case, exceed one-fourth of the breaking weight; and that the remaining three-fourths should be reserved to resist the rolling load in the proportion of six to one. He earnestly directed attention to the laws which governed the resisting powers of girders exposed to transverse strains, to the best principles of uniting the joints, and, above all, to the selection of the best material, which, in the parts of the girders subject to a tensile strain, ought always to sustain a test of from twenty-two to twenty-four tons per square inch. The use of superior metal for the bottom of the girders would give an increase of from one-fifth to one-sixth in the strength. There was no economy — and he wished particularly to impress this on the Section — in the use of

inferior iron for this purpose, and its employment inevitably led to a loss of character in the structure, and danger to the public.

CRYSTALLINE STRUCTURE OF IRON INDUCED BY VIBRATION.

The spontaneous change forged and rolled iron undergoes when submitted to continuous vibration, is productive of so much critical danger, especially in the case of railway machinery, that an investigation into the best means of remedying the resulting evils has been viewed as an engineering question of vital importance. Among others, Mr. Schimmelbuch, of Liege, has undertaken the subject, and the following is an epitome of his investigations: A bar of pure unalloyed iron was struck by a hammer three times in a minute for six consecutive weeks; at the expiration of this time it broke into three pieces. Before the experiment the bar was a good specimen of fibrous iron; after, on the contrary, its fracture exhibited a brilliant crystallized structure, resembling that of antimony.

A bar of iron alloyed with nickel, submitted to the same treatment, underwent no change.

A very simple means exists of recognizing this changed condition of iron, so dangerous in its consequences. Pure iron, when magnetized by contact, loses its magnetic properties immediately the needle is detached. On the other hand, iron combined with minute quantities of some foreign body, such as carbon, oxygen, sulphur or phosphorus, remains magnetized. The efficacy of this simple test has been established by repeated experiments.—*London Photographic News.*

Under the patronage of the Austrian government M. Bourville has also recently instituted a course of experiments with a view of throwing some additional light on the subject of the induction of a crystalline structure in wrought iron through vibrations.

M. Bourville's apparatus consisted of a bent axle, which was firmly fixed up to the elbow in timber, and which was subjected to torsion by means of a cog-wheel connected with the end of the horizontal part. At each turn the angle of torsion was twenty-four degrees. A shock was produced each time that the bar left one tenth to be raised by the next. Seven axles were submitted to the trial. In the first the movement lasted one hour, 10,800 revolutions, and 32,400 shocks being produced; the axle, two and six-tenths inches in diameter, was taken from the machine and broken by a hydraulic press, and no change in the texture of the iron was visible. In the second, a new axle, having been tried four hours, sustained 129,000 torsions, and was afterward broken by means of a hydraulic press; no alteration of the iron could be discovered by the naked eye on the surface of rupture, but, tried with a microscope, the fibres appeared without adhesion, like a bundle of needles.

A third axle was subjected, during twelve hours, to 338,000 torsions, and broken in two; a change in its texture and an increased size in the grain of the iron were observed by the naked eye. In the fourth, after one hundred and twenty hours, and 2,588,000 torsions, the axle was broken in many places; a considerable change in its texture was apparent, which was more striking toward the centre,

and the size of the grains diminished toward the extremities. In the fifth, an axle submitted to 23,328,000 torsions, during seven hundred and twenty hours, was completely changed in its texture; the fracture in the middle was crystalline, but not very scaly. In the sixth, after ten months, during which the axle was submitted to 78,732,000 torsions and shocks, fracture produced by a hydraulic press showed clearly an absolute transformation of the structure of the iron; the surface of rupture was scaly, like pewter. In the seventh and final case, an axle submitted to 128,304,000 torsions presented a surface of rupture like that in the preceding experiment; the crystals were found to be perfectly well defined, the iron having lost every appearance of wrought iron.

PROPERTIES OF A MIXTURE OF CAST-IRON AND NICKEL.

Meteoric iron, as well known, is the most ductile of all varieties of iron, and it is recorded by travellers that the Esquimaux have instruments made from it so ductile that they may be made to bend round the arm. All meteoric iron contains a small percentage of metallic nickel, and it has been suggested by chemists that by mixing iron and nickel artificially, an alloy of iron as strong and ductile as meteoric iron would be obtained. With a view of testing this theory, and with a hope of obtaining a metal of great tenacity, suitable for the casting of cannon and heavy ordnance, Mr. Fairbairn, the celebrated English engineer, has recently instituted a series of very carefully conducted experiments of mixing a certain proportion of nickel with cast iron. The result, however, has failed entirely to realize expectation, inasmuch as the ingots prepared were found to have less than one-half the power to resist impact that similar ingots of pure iron possessed.

"It is uncertain what might have been the results had the castings produced been treated as cast steel, and hammered out until they were rendered malleable and magnetic. This process was not, however, attempted, as, judging from the appearance of the fracture, they were more likely to crumble under the hammer than attain malleability."

In a report on the above subject to the Manchester Philosophical Society, Mr. Fairbairn says in conclusion, "During the last two years, innumerable experiments have been made to produce a metal of increased tenacity suitable for the construction of heavy ordnance; but the ultimate result appears to be, that there is no metal so well calculated to resist the explosion of gunpowder as a perfectly homogeneous mass of the best and purest cast iron, freed from sulphur and phosphorus."

COMPARATIVE STRENGTH OF COLD-ROLLED AND HOT-ROLLED IRON.

The following is the result of a series of experiments recently instituted by Mr. Fairbairn, the celebrated English engineer, upon the tensile strength of bars of wrought iron, rolled cold or hot:—

"The first experiment was on a bar of wrought iron, in the condition in which it is received from the manufacturer (black). The diameter of the piece experimented upon was 1.07 in.; its area, 0.85873 square inch. The laying on of a weight of 46,426 lbs. produced an elongation

on a length of 10 ins. to the extent of 1.30 in.; and the laying on of 50,346 lbs. produced an elongation of 2.00, with a breaking weight per square inch of, in pounds, 58,628, and in tons, 26.173. The diameter at the point of fracture, after this experiment, was 0.88 in. The second experiment was on a bar similar to the preceding, but rolled cold. Diameter, 1.00 in.; area, 0.7854 square inch. With a weight of 64,255 lbs. laid on, it elongated rapidly, and the breaking weight was per square inch, in pounds, 81,812, and in tons, 36.523. The third experiment was also on a bar of iron rolled cold, with a diameter and area similar to the foregoing. The elongation of a length of 10 ins. was, in inches, 0.6, when a weight of 62,545 lbs. was laid on. With 69,295 lbs. laid on, the elongation was 0.79 in., and the breaking weight per square inch 88,230 lbs., in tons 39.388. The diameter after fracture was 0.85. The fourth experiment was on a bar of similar iron to the preceding, turned in a lathe. Diameter and area same as in the two foregoing. With a weight laid on of 30,910 lbs. the elongation was 0.15, and 2.20 with a weight of 47,710 lbs. Here the breaking weight per square inch was, in pounds, 60,746, in tons, 27.119. The diameter after fracture was 0.80. Thus it will be seen, that in an untouched or black bar the breaking weight was 50,346 lbs.; per square inch 58,628 lbs., or 26.173 tons strength, the untouched bar being unity, 1.000. That the breaking weight of a bar rolled cold was 69,295 lbs.; per square inch 88,230 lbs., or 39.388 in tons strength, the untouched bar being unity, 1.505. The breaking weight of a turned bar was 47,710 lbs.; the breaking weight per square inch 60,746 lbs., or 27.119 in tons strength, the untouched bar being unity, 1.006. From this it is evident that the effect of consolidation by the process of cold rolling is to increase the tensile powers of resistance from 26.17 tons per square inch to 39.38 tons, being in the ratio of 1 : 1.5, one half increase of strength gained by the new process of cold rolling. When, however, the iron rolled cold has repassed through the fire, many of the pores before consolidated must again be opened, there arising a consequent diminution of the strength previously gained. Experiments made at Woolwich on the metal of a monster wrought-iron gun showed a strength of 50,624 lbs. in the direction of the grain, but of only 43,339 lbs. when strained across the grain."—*London Engineer.*

IRON IN BUILDINGS—USEFUL RULES.

From a paper recently read before the Liverpool Architectural Society, by Mr. Wm. Stubbs, we derive the following useful memoranda:—

The first point to be ascertained by an architect with a casting of iron is to find out what it has to do. The practical man wants simple tools. Science is always consistent with successful practice, therefore simple rules are sufficient. The following for iron pipes of ordinary sizes answers well, and it never has been published before. It is based upon the fact that a 10-inch pipe one inch thick will stand the pressure of 100 yards head of water. The coincidence of one inch of metal to every 10-inch diameter and 100 yards pressure should be remembered. For every inch in the diameter of pipe, increase or deduct

one-tenth of an inch, and for every yard of pressure increase or deduct one-hundredth of an inch.

In calculating the strength of columns great care is necessary. The safe plan is to find the diameter of a solid column necessary to bear the compression, and then distribute the same area of metal in tube form as a hollow column. . . . A solid column 10 feet long, and having an area of 10 square inches (good metal), will bear 10 tons pressure. This rule can be conveniently carried out, and it is safe and practical.

EXPERIMENTS WITH WIRE ROPE.

Some experiments, important to all persons engaged in the manufacture of wire ropes, or who may be accustomed to use them, have just been made by Mr. J. Daglish, who has communicated the results to the North of England Institute of Mining Engineers. The conclusions arrived at were, that half the strength of the rope was lost by heating the wire; that the ordinary joint is much weaker than any other portion of the rope; that if a flat rope was well spliced it was not weakened thereby, but if the workmanship was bad, it lost from twenty-five to thirty-three per cent. of its strength. In either event, a round wire rope spliced became thirteen per cent. weaker than before. Round steel-wire rope will bear more than double the weight required to break iron-wire rope of similar diameter.

PROTECTION OF IRON AND STEEL.

Professor Vogel recommends, for the protection of iron and steel tools against rust, a solution of white wax in benzine. Moderately heated benzine dissolves half its weight of wax; and if this solution be carefully applied to the tool with a brush, the evaporation leaves a very adhesive and permanent coating of wax, which will preserve the metal even from the action of acid vapors. — *Dingler's Polytechnisches Blatt.*

AMERICAN ZINC.

At Bethlehem, Pa., about thirty tons of metallic zinc are now produced weekly from the ore yielded by the mines of the Lehigh Zinc Co., and when the furnaces are all in operation the production will be increased to two thousand tons per annum. All the articles required in the manufacture of the zinc are made upon the premises, as retorts, muffels, fire-bricks, etc., of ingredients brought from the surrounding country, no foreign material being used. This zinc is claimed to be equal to the best distilled zinc sold by manufacturing chemists.

Heretofore, we think, metallic zinc has not been produced in quantity in the United States.

SHEET ZINC FOR ROOFING.

A report of a committee appointed by the Central Society of Architects, in Paris, recommends "that zinc, which was at first rejected, but is now so generally used, should be applied with great

care, as certain precautions, very simple, but never to be overlooked, are indispensable. Thus, contact with plaster, which contains a destructive salt, is to be avoided; also, contact with iron, which is very injurious, and liable to cause a rapid oxidation. Eave-gutters should always be supported by galvanized brackets, and no gutter or sheet zinc should be laid on oak boards."

ON ETCHING.

The *London Builder* furnishes the following practical notes on the subject of "*etching*," with a view of especially commending the work to amateurs in ornamentation.

First, as regards copper plates, — which in many respects have an advantage over steel for the use of amateurs, — procure a thin plate, properly polished on the surface, at any of the regularly-established coppersmiths. These can be had of the size of several feet down to a few inches. The surface of the plate being bright and free from tarnish, remove all grease with great care by washing with spirits of turpentine and then rubbing with very fine whitening and wash-leather. Care must be taken not to scratch the plate.

Having got rid of all grease, fix a hand-vice to one corner or some other convenient part of the plate; it is then ready for the reception of the etching-ground — a preparation chiefly composed of asphaltum, pitch, and virgin wax; there is, however, a great art in making this sufficiently plastic, so as to admit of its being properly spread upon the plate when heated. It is better, for ordinary purposes, to purchase it at the coppersmith's or tool-shop, where a supply can be had for about one shilling. A dabber, for the purpose of laying the ground on the plate, is also necessary. This is of a mushroom shape, and composed outwardly of very fine silk or kid leather, free from grease; the inside is padded with wool. This can be readily made by any person who has seen one of them. In order to prevent any grit or impurity which may chance to be in the etching-ground, it is better to tie it in silk. For the purpose of heating the plate, a hot iron, or a spirit lamp, placed below an iron frame on which the plate may rest, or other contrivance, may be used. Care is to be taken to make as little dust as possible. The metal must not be allowed to get too hot, for that would burn the etching-ground, and prevent it from sufficiently resisting the acid. The plate being of a proper heat, by drawing the etching-ground over the face a small quantity may be lodged upon it. This in the first instance is uneven; but may be spread in a flat, thin, even manner. Every part must be covered by the ground, or else the acid would leave such places as are bare liable to be corroded into holes. The ground, when this is spread on the surface, is of a light brown color, so delicate that it is difficult to see any pencil outline which might be transferred, or properly to see the scratches made by the etching-needle. In order to darken this, it is necessary, while the plate and etching-ground are still warm, to smoke it by the flame of a wax taper or candle. The flame must be kept moving about, and not allowed to touch the plate so closely as to burn the ground.

These operations, although simple, require some little practice and

experience; and it is, perhaps, a good plan either to take a lesson or two in ground-laying, and the other parts of this process, from an engraver, or else to get one of this profession to lay the ground and bite in the plate when etched.

The ground having been made ready and the plate cold, an outline of the subject, prepared on ordinary or tracing paper, should be damped and transferred by means of pressure. The best way to manage this is to take it to a copper-plate printer, who will do it effectually for a few pence; for those living in the country where such conveniences cannot properly be had, this transfer can be made by one of the ordinary letter-copying machines, or by going very delicately over the back of the outlines with a pencil or other instrument which is not too sharp.

This having been done, by means of an etching-point, which can be had at the tool-maker's, the design can be readily scratched upon the plate. Attention is needed to mark the lines quite through the ground. The hand should also be prevented from coming in contact with the ground, and all unnecessary scratches be carefully avoided. This may, to a considerable extent, be done by forming a bridge of a flat ruler, supported by pieces of card-board or folded paper.

Wherever the etching-ground has been passed through by the etching-needle, that part is liable to be eaten into a line by the application of acid; on no other portion, however, should the acid work.

It being necessary to cover the etching with an even depth of diluted acid (from a quarter to half an inch), in order to produce equality in the *biting*, it is needed to form a wall of wax round the margin of the work. The best material for this is beeswax with a small part of Burgundy-pitch added, and then the mixture boiled until the whole is well mixed. This, when needed for use, should be put into warm water, and then can be readily raised round the plate and pressed down by the fingers, and after that more firmly by the handle of the etching-point, so that a sort of tank is formed, which will contain the acid as long as it may be necessary.

With the greatest care scratches may be made, or it may be necessary to erase parts, or the wax-wall may not be sufficiently tight. In order to remedy this, turpentine-varnish, or the ordinary "Brunswick black" used for stoves, may be employed, thinned to a proper extent by turpentine, and applied with a black-lead pencil.

For the purpose of "biting in" the plate, as the engravers call it, nitric acid of the purest description should be mixed, — one part of acid and three parts water, — which should be stirred up with a feather or pencil. Soon the lines will be covered with minute globules; and, in proportion to the time the acid is allowed to remain, the etched lines will become thicker and deeper.

As a matter of course, in order to produce a delicate and refined effect, a variety of thicknesses of line is desirable; and, although much can be done by the pressure of the point, by hatching, doubling lines, etc., it is in most cases necessary to allow the acid different times of action; for instance, it will be desirable to keep distant mountains and landscape thin, and to bring out the foreground by bold and deep lines. In order to manage this, the acid must be poured off into a vessel for further use, and then the plate must be well

washed with clear water, and afterwards dried with a bellows or other means; then such parts of the etching as are of sufficient depth should be covered with the varnish, in the same manner as the blemishes to which we have referred. This operation may be performed any number of times, each time washing and drying the plate; this must be also done when the biting is completed; and then, by gently heating the back of the plate, the wall may be drawn off, and by means of a little spirit of turpentine and oil the surface of the plate may be cleared of the etching-ground. There are other operations, such as re-biting, re-etching (by touching with the graver), and by working with a point without the use of acid, etc., etc.; these, however, would require much space to describe, and this we will not just now do, as it is more particularly our object in mentioning the above to make operations which might be useful in many manufactures more readily understood.

In the same manner, but with the use of different acids, and on any scale, etching may be applied to steel, iron, brass, glass, and, lately, we are told, to porcelain. For steel, nitric acid very largely diluted with pyroligneous acid until it does not taste much stronger than vinegar, is best. On brass, we have seen diaper, and other ornaments, produced with great clearness and rapidity in the following manner. On large works, such as monumental brasses, experience has shown that in the biting, either by nitric or nitrous acid, before a great depth is got the biting of the lines is stopped by the formation of a black oxide, which it requires a very strong preparation of nitric and sulphuric acid to remove and keep in solution; and this after a time proves too strong, and tears up the ordinary etching-ground; it has, however, been found that turpentine-varnish, if allowed for a few days to harden, has a great resistance; and by the use of this, when diapers, etc., are outlined, the raised parts may be painted with the varnish, and, when hard, the acid applied; and it is astonishing what good effect may be produced by these means. Large surfaces for the relief of foliage, figures, letters, etc., may, by this means, be executed with rapidity, either for filling in with colored shellac or pigments.

The painting of these ornamental plates with varnish might be the means of affording employment to females, and probably the preparation of embossing, and otherwise ornamenting glass to be bitten by fluoric acid, might also be brought into far more extensive use than it is at present, and would also provide a certain amount of respectable labor for females.

A NEW SYSTEM OF ENGRAVING.

A new method of engraving has recently been patented in England by George Wallis, of London. Pulverized materials, sufficiently hard to be pressed into the metallic plate to be engraved, are mixed to a suitable paste, the picture is formed with this paste upon paper, vegetable parchment, or other fibrous material, which is then laid upon the metal plate and passed with it between two rollers, subjecting it to a pressure sufficiently powerful to sink the hard material of the paste into the metal, thus forming the engraving.

The metal plates which may be most conveniently impressed by drawings, designs, prints, or photographs, prepared according to this invention, are plates of Britannia metal, copper and German silver; but plates of various other metals and metallic alloys may be similarly impressed.

As a preparation of the plate before engraving or impressing a drawing, design, or photograph upon it, as described, the said plate is usually passed several times through the machine, the surface to be impressed being placed in contact with the surface of the plane or bed of the machine. When a drawing or photograph is executed upon a slab of plate-glass, the metal plate to be engraved or impressed is first passed through the machine upon the usual plane, and after the plate has been passed through the machine several times the plane is removed, and the slab on which the drawing or photograph is executed is substituted for it. The plate of metal is then passed through the machine in contact with the drawing.

The patentee gives the following formulas for preparing the paste with the mixtures of hard substances:—

Formula No. 1.—30 parts (by weight) of peroxyd of tin, 2 peroxyd of manganese, 10 Venetian red, 5 Paris white, 3 rice starch, 8 gum arabic, 2 bichromate of ammonia.

Formula No. 2.—20 parts (by weight) of peroxyd of tin, 10 peroxyd of manganese, 10 Indian red, 5 Paris white, 3 rice starch, 10 gum arabic, 2 bichromate of ammonia.

Formula No. 3.—15 parts (by weight) of finely-powdered emery, 10 Indian red, 10 peroxyd of manganese, 5 Paris white, 5 rice starch, 8 gum arabic, 2 bichromate of ammonia.

When making the drawing, design, or writing upon a sheet of gelatine, a sufficient quantity of the composition described in formula No. 1 is used, adding as much water as will cause it to flow freely from a pen, or brush, or hair pencil. After being allowed to stand a few minutes to dissolve the gum arabic, the whole is mixed together to about the consistency of ordinary cream. With this are drawn the outlines of the subject, and the other portions in lines and distinctly marked touches to which it may be artistically best adapted. When dry, and after a brief exposure to daylight and the atmosphere, in order that the bichromate of ammonia may act upon the gum arabic and starch, and thus secure the drawing from ready disturbance, the touches are repeated upon such parts of the lines or markings as may not stand out in sufficient relief. For those portions of the lines or markings which it is desirable should be more strongly defined, the composition described in formula No. 2 is used; and for the parts in which it is intended the lines and markings should be darkest and strongest, the composition described in formula No. 3, mixed with water as before described, is used.

When a drawing or design is executed on paper, vegetable parchment, tracing-cloth, or other suitable fibrous material, the fibrous subtance is impressed in the metal plate as well as the drawing or design, and when printed in the manner of copper-plate printing, the impression of the fibre gives a tint all over the drawing or design. To produce a proper effect of light and shadow, the same method is followed as that used in ordinary mezzotinto engraving. If the texture or

depth of tint produced by the fibre of the paper is desired to be increased in those impressions on metal which are treated in the manner of mezzotinto engravings, the paper is coated, before commencing the drawing or design, with the composition formula No. 1, mixed with water to the consistency best adapted to produce the desired effect, and after the same is dry, and properly fixed by time or the action of light, the drawing or design is made upon the surface thus produced.

The drawing or writing, executed as described, presents, when the material is dry, a surface in relief which is capable of impressing or engraving a metal surface; and such impression or engraving is capable of giving an impression, according to the artistic method of execution, either in the manner of copper-plate printing, or in that of printing from wood blocks, or for the purpose of transfer to lithographic stones or zinc plates, for the purpose of printing from in the manner of lithography or zincography, or for the transfer of designs to porcelain, earthenware, or Japanware. To obtain an impression which will print in the manner of copper-plate printing, that is to say, an impression in intaglio, the patentee executes the lines or touches of the drawing he desires to impress or engrave upon a suitable material, such as paper, the parts when impressed or engraved in the metal surface being capable of retaining the printing ink, and thus giving an impression. To obtain an impression which will print in the manner of a wood block, that is to say, in relievo, he paints or draws upon those portions which it is desired should not be printed from, and thus these parts being depressed in the operation of impressing upon a metal plate or surface by suitable machinery, those parts which it is desired to print from are in relief, in the manner of a wood block. Drawings, writings, and designs are also prepared by making the drawing-materials sufficiently glutinous by the addition of a large proportion of gum arabic; and after the drawing, writing, or design has been damped, it is supplemented by the addition of a further quantity of the powdered solid, leaving out the glutinous substances and the chromic salt. In this case, when the drawing is completely finished, it is floated with the back downward upon water in a suitable vessel; and when, upon examination, the glutinous material has become sufficiently damp, it is taken from the water and placed upon a flat board, and the material which already constitutes the drawing is supplemented by dusting it with powdered glass, peroxyd of tin, or emery.

ORNAMENTAL BOOKBINDING.

An interesting process in ornamental bookbinding has been recently patented by Mr. Charles Tuckett, of London. This is a method by which various colored designs are produced on the sides and backs of books, according to taste and pattern, by means of numerous acids, alkalies, salts, mineral and neutral, and their compounds, acting in such a manner as to cause a permanent change of color on the foundation leather. That is to say, the volumes being first bound in leather of a uniform color, as red, olive, blue, or green, any other color or colors may be superadded at will by the new process, and with little

or no fear of time operating any change in them. Some beautiful specimens of bookbinding of this kind have been exhibited by Mr. Tuckett at the Society of Arts. The morocco bindings are far superior to those in calf, the changes of color in the former being of a more decided hue than in the calf, affording another evidence, if such were needed, of the superiority of morocco to calf under all circumstances of bookbinding. Connoisseurs are, of course, aware of many curious and valuable examples of bookbinding in various colors, dating back as far as the sixteenth century, which were produced either by painting the added colors with oil, or by inlaying portions of leather of the various required hues. But both of these methods are objectionable; the one from the danger and almost certainty of the added colors chipping off in process of use, and the other from the various inlaid pieces becoming loose at the points of juncture. Another, and far cheaper, process has more recently come into vogue, namely, that of laying strips of colored paper on the surface of the leather, with a view to obtain the desired ornamentation. But this, for obvious reasons, especially the absence of durability, is more objectionable than either of the two former, while Mr. Tuckett's has clearly the advantage over all three. We understand that the new process can be also effectively used in the manufacture of picture-frames, ornamental chairs, tables, and other articles of upholstery, in which durability, combined with beauty of design and colors, is the object sought to be obtained.—*London Athenæum.*

NOMENCLATURE OF PRINTED STUFFS.

M. Chevreul has read to the French Academy of Sciences a memoir on the distinctions which would give the most perfect security to commerce as to the stability of the colors on stuffs, without interfering with the freedom of business. In place of the vague and useless distinctions now adopted, he proposes the following: *very stable*, *stable*, *moderately stable*, *changeable;* expressed in numbers, or in the degrees of the chromatic scale which the prints lose after one, six, or twelve months' exposure to the light and air. There is but one very stable color, that is, *indigo*, applied by M. Chevreul's process, by passing through steam. Indigo applied by the old process is merely stable; cochineal and madder, with certain mordants, are stable; with other mordants they are only moderately stable, as is weld (*reseda luteola*). Brazil and Campeachy woods are moderately stable. Annotta (*biza orellana*), turmeric, and safflower are changeable.

M. Chevreul regrets that certain new colors, such as *muroxide*, *orcëine*, *fuchsine*, *azalëine*, which are very beautiful and agreeable to the eye at first, but very changeable, should have been over-praised of late, at the expense of the old and stable colors, indigo, cochineal, weld, which will remain alone, or nearly alone, in the manufactories, when their rivals have disappeared.

MANUFACTURE OF PAPIER MACHE.

The following description of the processes followed on a large scale for the manufacture of *papier mache*, is taken from the columns of the London *Ironworker.*

There are at present five principal varieties of *papier mache* known in the trade, viz.: 1. Sheets of paper pasted together upon models. 2. Thick sheets or boards produced by pressing ordinary paper pulp between dies. 3. *Fibrous slab*, which is made of the coarse varieties of fibre only, mixed with some earthy matter, and certain chemical agents introduced for the purpose of rendering the mass incombustible; a cementing size is added, and the whole well kneaded together with the aid of steam. The kneaded mass is passed repeatedly through iron rollers, which squeeze it out to a perfectly uniform thickness; it is then dried at a proper temperature. 4. *Carton pierre*, which is made of pulp or paper mixed with whiting and glue, pressed into plaster piece-moulds, backed with paper, and, when sufficiently set, hardened by drying in a hot room. 5. *Martin's Ceramic papier mache*, a new composition, patented in 1858, which consists of paper pulp, rosin, glue, drying oil, and sugar of lead, mixed in certain fixed proportions and kneaded together. This composition is extremely plastic, and may be worked, pressed, or moulded into any required form. It may be preserved in this plastic condition for several months by keeping the air away, and occasionally kneading the mass.

The first-mentioned variety of *papier mache* alone engages our attention here. A special kind of paper, of a porous texture, is manufactured for this purpose. An iron mould of somewhat smaller size than the object required is greased with Russian tallow, a sheet of the paper is laid on to the greased surface of the mould, and covered over with a coat of paste made of the best biscuit-flour and glue, which is spread evenly all over the sheet with the hands; another sheet is then laid on, and rubbed down evenly, so that the two sheets are closely pasted together at all points. After this the mould is taken to the drying chamber, where it is exposed to a temperature of about one hundred and twenty degrees; when quite dry, which it takes several hours to accomplish, it is carried back to the pasting-room, and another sheet laid on with another coat of paste, after which it is returned to the drying chamber; and the same operation is repeated over and over again, until sufficient thickness is attained, which, for superior articles, such as are manufactured at these works, requires from thirty to forty sheets of paper, and of course as many coats of paste between. The shell is then removed from the mould, and planed to shape with a carpenter's plane, after which it is dipped in linseed oil and spirits of tar to harden it; this changes the color from gray to a dingy yellowish-brown tint. The article is then stoved, and seven or eight coats of varnish are laid on (with a stoving after each), which are cleared off each time, any inequalities of surface being finally removed with pumice-stone. The number of drying processes the articles have to go through consume so much time, that it takes three or four weeks to fit them for ornamentation, which is applied in bronze-powder, gold or color, and for many articles also in mother-of-pearl. The ornamentation of these articles is sometimes effected in the highest style of the painter's art.

The gold-leaf is laid on with a solution of isinglass in water, the design then pencilled on with asphaltum, the superfluous gold removed with a dossil of cotton dipped in water, which leaves intact

the parts touched with asphaltum, and the latter finally removed with essence of turpentine.

After the application of every coat of color or varnish, the object so colored or varnished is dried in an oven or chamber, called a stove, and heated by flues to as high a temperature as can safely be employed without injuring the articles, or causing the varnish to blister.

For black grounds, drop ivory-black mixed with dark-colored anime varnish is used; for colored grounds, the ordinary painter's colors, ground with linseed oil or turpentine, and mixed with anime varnish.

The colors are protected against atmospheric influences, and made to shine with greater brilliancy, by two or three coats of copal or anime varnish. Superior articles receive as many as five or six coats of varnish, and are finally polished.

The ornamentation of all such articles as come under the head of toilet wares is effected by the ordinary mode of painting with the camel's-hair pencil, or some fitting substitute; where imitation of woods or marble is intended, the ordinary grainer's tools are used. Many patterns are produced upon the various articles by "transfer-printing."

Designs in mother-of-pearl are laid on with black varnish, the article is then varnished all over, dried, then rubbed down over the design with pumice-stone; another coat of varnish is then laid on, dried, and the part covering the design again rubbed off with pumice-stone; and thus several coats are laid on, until all the surface is level with that of the design. Ornamental lines, writing, etc., are laid on with color. The inlaying with mother-of-pearl is a laborious business, owing to the small size of the pieces at the artist's disposal, and the necessity of attending to a proper distribution and fitting of lights and shades.

INDIA RUBBER VARNISH.

That India rubber, dissolved in various liquids, yields a good varnish, is well known; but in general they are too viscid for delicate purposes, and are only good for making stuffs waterproof. India rubber liquefied by heat, dissolved in oil of tar, or drying linseed oil, does not give a varnish of sufficient fluency, or free from smell. Moreover, a considerable quantity of India rubber remains undissolved in a gelatinous state, suspended in the liquid, so that the solution is never clear. Dr. Bolley has recently published some remarks on this subject, which may be useful. If India rubber be cut into small pieces and digested in sulphuret of carbon, a jelly will be formed; this must be treated with benzine, and thus a much greater proportion of caoutchouc will be dissolved than would be done by any other method. The liquid must be strained through a woollen cloth, and the sulphuret of carbon be drawn off by evaporation in a water-bath; after which the remaining liquid may be diluted at will with benzine, by which means a transparent, but still yellowish liquid, will be obtained. A more colorless solution may be prepared by digesting India rubber cut into small pieces for many days in benzine, and frequently shaking the bottle which contains it. The jelly thus formed will partly

dissolve, yielding a liquid which is thicker than benzine, and may be obtained very clear by filtration and rest. The residue may be separated by straining, and will furnish an excellent waterproof composition. As for the liquid itself, it incorporates easily with all fixed or volatile oils. It dries very fast, and does not shine, unless mixed with resinous varnishes. It is extremely flexible, may be spread in very thin layers, and remains unaltered under the influence of air and light. It may be employed to varnish geographical maps of prints, because it does not affect the whiteness of the paper, does not reflect light disagreeably, as resinous varnishes do; and is not subject to crack, or come off in scales. It may be used to fix black-chalk or pencil drawings; and unsized paper, when covered with this varnish, may be written on with ink.

NEW APPLICATIONS OF GUN-COTTON.

The London *Chemical News* refers approvingly to a patent recently obtained in England by S. Branwell and A. Rollason, for obtaining new and peculiar products from mixtures of gun-cotton (pyroxyline) with various substances.

In order to obtain cheap gun-cotton, the patentees state it may be made of rags instead of new cotton. It is first dissolved in any of its solvents, such as ether and alcohol, and becomes collodion. To this is now added any of the purest animal and vegetable oils, and it forms the new liquid which is to be used as a cement and vehicle. By adding to it gums and resins a cement is formed, which may be rolled out into sheets and stamped in dies into cups, fancy boxes, and various other articles. The oxyd of copper imparts a green color to it, and the chloride of lime added renders it uninflammable. The addition of fine flax fibre or the *flocks* of wool render it strong and flexible. It is stated to be an excellent compound for taking casts required for the purposes of dentistry, the models of jewellers, and other articles requiring sharp and smooth edges and sides.

The collodion oil-liquid, when very thin, may also be employed as a varnish for pictures, prints, etc.

THE PNEUMATIC DISPATCH.

For some months past (see *Annual of Sci. Dis.*, 1861), a Pneumatic Dispatch Company has been in operation in London, pipes of a few inches in diameter being laid, through which small parcels were sent to various parts of the city. The company, finding the system to work well, have decided to enlarge the tubes to a height of two feet nine inches and to a width of two feet six inches, and ultimately extend their system throughout the whole metropolis. Preliminary to this, the following experimental trials have been instituted, for the purpose of effectually testing the project, on a vacant piece of ground adjacent to London. A quarter of a mile of the tubing has been laid down; various irregular curves and gradients being introduced, to show that hills and valleys would not prevent the effective working of the system. Under a temporary shed, a high-pressure steam-engine of thirty horse power, having its cylinder

placed at an angle of forty-five degrees, has been erected, and gives direct motion through the medium of a crank to a large disk of sheet-iron. The disk runs on tubular bearings, and narrows from about two feet six inches in breadth at its centre to three inches at its circumference, its diameter being eighteen feet. Its interior contains simply four arms, to which the sheets of iron are fastened, and which serve as fans or exhausters. Through the hollow bearings, upon which the disk is made to rotate at a speed of from one hundred and fifty to two hundred revolutions per minute, a communication exists with a vacuum chamber below, and, by the laws of centrifugal action, the latter is speedily exhausted, to a certain extent, of air. The speed, in fact, of the disk determines that extent, and a water barometer registers it. The air rushes out with considerable force from the periphery of the disk. Between the vacuum chamber and the pneumatic tube, which is two feet nine inches high, by two feet six inches in breadth, and a transverse section of which resembles that of the Thames tunnel, there are fitted valves with hand levers for opening and shutting them. These may be said to comprise the whole of the motive and propelling agencies of the pneumatic system.

The tube through which the dispatch trucks are drawn is not circular in form, but of a section resembling that of an ordinary railway tunnel; the internal height being two feet nine inches, the width at the springing of the arch (the top being semi-circular) two feet six inches, and at the springing of the invert (for the tube has a segmental bottom) two feet four inches. The tube is of cast iron, in nine-feet lengths, each weighing about one ton, and fitted into each other with an ordinary socket joint, packed with lead. Within the tube, and at the lower angles on either side, are cast raised ledges, two inches wide on the top, and one inch high, answering the purpose of rails for the wheels of the dispatch trucks to run upon. The latter are made of a framing seven or eight feet long, inclosed in sheet iron, and having four flanged wheels, twenty inches in diameter each. The whole truck is so made that its external form, in cross section, conforms to that of the tube, although it does not fit it closely, an intervening space of an inch or so being left all around. Some light India rubber flanges or ringes are applied at each end of the truck, but even these do not actually fit the inner surface of the tube, a slight "windage" being left around the whole truck. There is no friction, therefore; and, singular to say, the leakage of air does not interfere with the speed of transit. This can only be accounted for by the large end area which the carriages have, in comparison with the small area of leakage space and the comparatively low vacuum required. The first experiment made was by loading a carriage with one ton of cement in bags, and entering it into the open end of the tube. Upon a given signal the engineer to the company caused the starting valve to be opened, the water barometer showing a column of seven inches in height, and the disk running at the rate of one hundred and fifty revolutions per minute. In fifty seconds later the carriage with its contents found its way into the engine house, through a door at the end of a tube, which it forced open, and then ran forward on rails to a butt placed to stop its progress. Next two tons weight were placed in one of the carriages, and its transit occupied eighty seconds, under

similar circumstances. The vacuum was now lowered until the barometer gauge showed two inches of water only, and a living passenger, in the shape of a not very handsome dog, was placed, with one ton weight of dead stock, in a carriage. The signal was made by the workmen at the open end of the tube, the communicating valve was opened, and in one minute and a half the carriage and its four-legged guard were in the engine house, the latter apparently not at all the worse for the exhausting process to which he had been subjected.

Subsequently two gentlemen were sent through the tube with equal success and celerity. They lay in one of the carriages, on their backs, on mattresses, and reported themselves as experiencing no inconvenience.

The speed with heavy loads thus far obtained is only about twenty-five miles an hour; but as this includes the starting and stopping in the short space of a quarter of a mile, the company anticipate a speed ultimately of thirty or forty miles an hour. By forcing air into one end of the tube and drawing it out at the other this speed may be multiplied several fold.

It is the intention of the company, now that they have obtained parliamentary powers for opening the streets to lay down their tubes, to establish a line between St. Martin's-le-Grand and one of the district post-offices, and ultimately to extend their system throughout the metropolis, so as to connect the railway stations and public offices.

NEW MODE OF PRESERVING IMPRESSIONS IN SAND, ETC.

The murder of an eminent banker on a French railway has given rise to a very ingenious plan of rendering permanent marks in sand or any other yielding soil, and which may possibly be found useful in many cases where it is desirable to preserve an impression that would otherwise be soon obliterated. The process is the invention of M. Hugoulin; and the manner in which it has been applied, to preserve the marks made by the criminal's feet in the sandy ground of the station where he leaped from the train, is as follows: — A sheet of thin iron plate was placed over the marks made, and supported by an iron stand at a distance of about an inch and a half from the surface of the ground; a quantity of lighted charcoal was then placed on the iron plate, which soon became red hot, and of course heated the spot over which it was placed. When the latter was raised to 100° Centigrade (212° Fah.), the fire, together with the plate, was removed, and a quantity of finely divided stearic acid was strewed over the impression by means of a sieve. The powder used was that of a common stearine candle, dissolved by heat in alcohol, and then thrown into a large quantity of cold water, when the stearine falls to the bottom in the form of a fine precipitate. This powder is so light and impalpable, that it is said it might be sifted over an impression in the dust of a common road, without in the slightest degree interfering with the faintest mark. The instant it touched the heated surface of the ground in question, it melted, and, as it were, sealed the whole of the loose atoms into one compact mass. When a sufficient quantity

of the stearine had been applied, the place was left until it had become completely cold; the surrounding earth was then dug out carefully at some little distance from the edges of the impression, and the portion containing this latter was lifted up in one entire block, and laid on a cloth several times doubled, the edges of which were raised up so as to form a kind of border, or rather framing, into which, and against the sides of the sandy earth containing the impression, plaster of paris was poured; and when the latter was set, the whole could be handled without danger, and was firm enough to bear packing and carriage to any distance. It is evident, therefore, that, if necessary, it might also be used as a mould, from which casts in plaster could be obtained. The value of such a process, as an aid in criminal cases, is too self-evident to require demonstration; the production of the tell-tale impressions in a court of justice, where every mark can be conveniently exhibited and compared with the object by which it was produced, may be equally useful in the proof of guilt and of innocence, and it would be strange indeed if a use for such a process be not discovered in matters of scientific or practical interest.

FILTRATION AND FILTRATION MEDIA.

The following is an abstract of a paper on the above subject recently read before the London Society of Arts, by Julius Dahlke, Esq.

"During the past seventy years, gravel, sand, and charcoal, used as a mixture, have been the agents most in vogue amongst filter makers, and it is only lately that due attention has been paid to charcoal as the most efficient filtering medium. Its use is much more frequent now, because not only has it a powerful detergent effect, but it possesses also the peculiar advantage of not becoming foul, while it protects from decomposition other bodies in contact with it. It has been often asked why animal charcoal is so effective as a filtering medium. Some attribute this to the presence of so much carbon; but that this is an insufficient reason, is shown by the fact that, although coke contains more carbon than sand, yet it is not superior as a filtering agent. Animal charcoal filters about three and a half times more rapidly than either coke or sand, while it is also greatly superior in this, that it removes many inorganic impurities held in solution, over which the former substances exert no power. It appears that the more porosity a filtering medium possesses in itself, the more rapidly does it filter, and the greater is the effect it produces on the water. The latter will be still more decided when, with a greater porosity, peculiar substances are combined.

"This leads me to believe that we may attribute the extraordinary filtering quality of animal charcoal to the fact that its principal component parts are lime and carbon, so combined as to secure a wonderfully fine porosity. Vegetable charcoal, although very porous, and containing far more carbon, has less effect on water. Although we know of powerful agents for the removal of different impurities from water, circumstances may and do interpose which

render it extremely difficult to obtain the medium in the requisite form for our purpose, and there is nothing yet discovered which will perfectly meet all the requirements of the case. Those who assert that it is possible to construct an apparatus to act as a universal filter for purifying any kind of water effectively, whatever may be the impurities, remind me of the vendors of certain patent medicines, who vaunt their nostrums as capable of curing every disease. Their claims are about equally trustworthy.

"I should classify the art of filtration into three systems, viz: 1st, where the action takes place simply on the surface of the filtering medium; 2d, where the whole bulk of the filtering medium is calculated to operate on the water, and the detergent effect in its most delicate form may be produced; and, 3d, where both of these systems are conjointly employed.

"The first system requires a filtering medium of such a fine porosity that its pores must be smaller than the minute particles composing the impurities suspended in the water. Such an agent of course must sooner become clogged than a filtering medium of coarser porosity, and which is meant to act with its whole bulk on the water. But both systems employed together may prove to be useful in several instances, as in the case of domestic filters. The greatest failing of these is, that they must become clogged, and the more they are liable to this, the more effectively they act. We often hear of self-cleansing domestic filters, but the fact is that no invention of the kind has been made yet, without involving complications too great for the purposes of ordinary domestic use. However, it is not difficult to make a filter for general domestic purposes, although the effective self-cleansing of such an apparatus is still a problem to be solved.

"If the filtering medium employed in this case be solid, and of a fine porosity in its upper part, the clogging impurities will not only be retained on the surface, but may be easily removed by scraping; and then, if the lower part of the filtering medium be prepared of a material capable of producing a detergent effect, it will act the more readily through not being interfered with by the rougher and clogging impurities. It should be remembered, too, that in most cases we have here only to deal with some rougher impurities which have found their way into the water on its passage from water-works, or other source, to the tap of the consumer.

"The difficulty, or I may say the impossibility, of keeping water which is stored in cisterns entirely free from accidental contamination, should lead us to provide a domestic filter capable of removing chemical impurities, as, for example, any lead which may be held in solution; in fact, the practice of filtering water preserved in cisterns and intended for domestic use cannot be too warmly recommended.

"To remove lead from water, Professor Faraday recommends the practice of stirring up animal charcoal with the water so contaminated, the same being then allowed to settle.

"It is easy enough to purify small quantities of water, but the greater the quantity the greater are the difficulties of purification especially when a certain chemical effect has to be produced.

"It will not be necessary for me to dwell upon the filtering processes required for large water-works, as the supply is generally taken from such sources that the common sand filter-bed answers the purpose; and where the water is too hard for domestic uses, the beautiful process of Dr. Clark will meet and remedy the evil.

"Experience shows that it is not prudent to adopt the same means of purification for every kind of water, and I should make a difference in the treatment of the water used for domestic and that employed for manufacturing purposes. In the latter it will be often of the greatest importance to have the water as pure as possible, whereas certain so-called impurities in water may not be at all injurious to health. When we consider that no one would call human blood impure which contained four hundred and twenty grains of saline matter per gallon, I do not know that we are justified (of course, speaking in relation to health) in calling water impure which contains small quantities of certain saline matters, particularly when we have no medical evidence that the small portions of them drunk in such water ever did any harm. Besides which, it should be remarked that the quantity of lime and magnesian salts drunk in water must be greatly exceeded in amount by that which enters the system in the food."

Mr. Dahlke states that he preferred animal charcoal to all other filtering media, and regretted that no practical method is yet known of moulding it into blocks without diminishing its powers. Charcoal, he said, as regards its filtering qualities, stands to coke as fifteen to four, and all attempts at solidifying it by calcination with pitch, tar, etc., have failed in practice, owing to the glazing effects of the bitumen, which greatly impairs its action. He had, however, found that the residue, after distillation, of the well-known Torbane-hill mineral, with a small addition of fine clay, will, if saturated with fatty or oily matter, and calcined, furnish a very powerful filtering medium, capable of reducing the hardness of water, and removing its color and odor. He also adds bone-dust, both to improve the quality of the "filter-blocks," and in order to regulate their degree of porosity with greater precision.

SUBSTITUTE FOR GLUE — VEGETABLE ALBUMEN.

An improved process has been invented by E. J. Hanon, of Paris, by which he obtains vegetable albumen from gluten, for the purpose of applying it as a cheap agent for fixing printed colors on textile fabrics, and also for uniting pieces of wood, leather, etc. The following is the substance of the specification, as published in *Newton's London Journal of Arts:* —

Gluten is obtained by kneading wheat flour paste with water. During the operation of kneading, the feculent part of the paste is carried off with the water, and the glutinous parts unite and form an elastic substance called gluten, which contains about twice its weight of water; the gluten, in this state, is converted into vegetable albumen, by the process of fermentation. In carrying out the invention, gluten of the best quality, free from fecula, and after having been well washed in warm water, is placed in vessels, in

which it is left to ferment until it is completely soft, and has lost its elasticity, and until the greater portion of the water which it has taken up during the operation of kneading is combined with it; when the gluten has undergone the requisite fermentation or modification, it offers no resistance to the finger, or to any article which may be passed through the mass, and the modified gluten should also adhere to the object with which it is brought in contact. The gluten, so modified, is then ready for use; but, as it has been brought, by the process of fermentation, into a very thin paste, it is necessary to place it in moulds for drying.

The process of fermentation may be performed either with or without the aid of artificial heat; when artificial heat is applied, the process is considerably expedited, and the heat found most beneficial is about 20° to 30° Fah. above the temperature of the surrounding atmosphere. During the fermentation, it is requisite to stir the gluten frequently, and to remove the water which rises to the surface. With the above temperature, and in operating upon about fifty or sixty pounds of gluten, placed in a vessel, the fermentation will be sufficiently advanced in three or four days, and the fermented gluten or vegetable albumen will then be in the proper state for being made into thin plates and dried. The greatest care must be taken that the fermentation is stopped at the proper point, for if it is allowed to proceed too far the gluten is converted into a noxious mass.

When the gluten is converted into vegetable albumen, it is divided, and formed into plates of about one-quarter to three-eighths of an inch in thickness; this is effected by spreading the albumen in metal or other moulds, by means of a spatula; it is then left to dry, either in the open air or by the aid of a gentle heat, and the plates, when dry, are about one-eighth of an inch in thickness. One pound of the so-called vegetable albumen to one pound and a half of water will give a solution which may be used as a substitute for the strongest glue or gelatine, and which resists moisture to a great extent, and is not influenced by heat.

The solution may be used cold, and will retain its properties for from ten to fifteen days in summer, and twice as long in winter, that is to say, if it is kept cool, and, if possible, in a current of air.

THE LARGEST CHIMNEY IN THE WORLD.

Mr. Duncan Macfarlane, of Glasgow, C. E., an architect, has published a description of the colossal chimney recently completed at Messrs. Townsend's Chemical Works, Port Dundas, Scotland. It is described as being not only the largest structure of the kind, but the loftiest building in the world, excepting the Great Pyramid of Ghizeh, the spire of Strasburg Cathedral, and that of St. Stephen's, Vienna. This chimney is circular in plan.

Total height from foundation	468 feet.
Height above ground	454 "
Outside diameter at level of ground	32 "
Outside diameter at top	14 "
Thickness at level of ground	7 bricks.
Thickness at top	1½ "

In a report made on its probable stability, Professor Rankine says: "From previous experiments on the strength of the bricks used in the chimney, I consider that their average resistance to crushing is ninety tons per square foot. I calculate that, at the level of the ground, the pressure on the bricks arising from the weight of the chimney will be about nine tons per square foot, or one-tenth of the crushing pressure. I consider that, in violent storms, the pressure on the bricks at the leeward side of the chimney may sometimes be increased to about fifteen tons per square foot, or one-sixth of the crushing force. On these grounds, I am of opinion that the chimney, if executed as designed, will be safe against injury by crushing of the bricks." On the 9th of September, 1859, however, after a hurried construction, a violent storm swayed it from the perpendicular, the deflection produced extending to seven feet nine inches. On the 21st of the same month, and subsequent days, it was restored to the perpendicular by twelve separate sawcuts, as recommended by Mr. D. Macfarlane, architect, who afterwards reported, as did Mr. Rankine, that it was then perfectly safe. The highest cut was one hundred and twenty-eight feet from the top, and the least distance between any two cuts was twelve feet.

A SUBSTITUE FOR EXTERNAL CHIMNEYS.

M. M. De Janges and Masson, in a communication made recently to the French Academy of Sciences, have shown how external chimneys may be dispensed with. They propose that the upper apertures of all the chimneys of a house should be received into a chamber at the highest part of the edifice, whence the smoke shall escape by one aperture only. They also propose that the hot vapor shall be utilized in various ways. M. De Janges enumerates among the advantages of his system, which has been tried at Neuilly, that the draught in the chimneys is constant and equal, that conflagrations may be more easily extinguished, and that fifty per cent. is saved of the cost of removing soot.

RUNAWAY HORSES — A NEW CHECK.

A great many patents have been taken out of late years for stopping runaway horses, and in almost every saddler's shop we see engravings of apparatus devised to squeeze a horse's throat, or nose, or to catch up one leg and throw him down. But to all this machinery it is objected that if a horse is really running away at a great pace he cannot be stopped suddenly by violent means without considerable risk both to man and beast. A very ingenious invention, operating upon the horse's movements by moral force alone, has been recently brought out by M. Lévêque, a French officer of the Cavalry School of Saumur. His plan will assuredly not be approved of by those who object altogether to the use of blinkers, for it is but an extension of the blinker system. The partisans of blinkers, however, for horses in harness, are, up to the present time, in an enormous majority.

The leading idea of M. Lévêque's invention is to induce the horse

by his own natural instincts, and without any mechanical force, to hold his head in such a position that the bit shall act properly upon his mouth. Inside of each blinker he places a sort of leather fan, called a *lunette d'arrêt*, which opens or shuts at pleasure by means of a safety rein. When developed, it only partially blinds the horse, and it is in the natural action of the horse to avail himself of the sight left him that the virtue of the system consists. If he throws up his head to run away, and the lunette is opened, he can see nothing but the sky, and he then inevitably brings his head down to the proper position in order that he may see straight before him. If, on the contrary, the habit of the horse be to escape the action of the bit by curving his neck till the chin almost touches his breast, the apparatus may be so adjusted as to prevent him from seeing anything but the ground, and he naturally raises his head. Thus the lunette acts both as a bearing-rein and a martingale, but more certainly, and without the dangers and inconveniences of those contrivances. For horses addicted to shying, the apparatus is particularly useful. As soon as the horse pricks his ears to shy at any object lying in the road, the driver has only to raise the lunette, and the animal, seeing only the distant horizon, and nothing immediately about him, will go by or even right through the thing which frightened him without taking the least notice. At an exhibition on the *Champs de Mars* in Paris, horses went unhesitatingly through the flames and smoke of lighted lumps of straw, which but a moment before, when the lunettes were folded, they could not be made to approach.

The apparatus is intended chiefly for horses in harness, but there is a form of it adapted for saddle-horses. Of course a hard-mouthed horse cannot unfailingly be prevented from running away merely by the use of this lunette, but a great deal is done towards diminishing the danger when his head is got into a proper position, because he will then surely be pulled up before long, and in the meanwhile the driver can guide him.

ARTIFICIAL HOOFS FOR HORSES.

It is impossible to calculate the various useful purposes to which gutta percha may be applied. One of the most ingenious applications recently made of this valuable substance, is that of making artificial hoofs for horses' feet. Many ingenious devices have been resorted to, to attain this result, but the adoption of gutta percha will, doubtless, supersede all others, as soon as its efficacy becomes recognized. What is required by the veterinary surgeon, is a substance possessing the consistence of horn, to retain the nails of the shoe; that will readily soften by heat, so as to mould itself to the required form; that it be indissoluble in water, seeing that the horse's hoof is generally in contact with moisture; and, lastly, that it be capable of uniting perfectly with the hoof. No known substance possesses all these qualities except gutta percha. For the purpose under consideration it is prepared by being cut into fragments the size of a nut and softened in hot water; the pieces are then mixed with half their weight of powdered sal-ammoniac, and melted together in a tinned saucepan over a gentle fire, keeping the mass well stirred;

the mixture should assume a chocolate color. When required for use it should be melted in a glue-pot; the surface of the hoof must be scraped clean, and the gutta percha applied as required. The application may be facilitated by the use of a glazier's knife warmed, by which also the surface of the artificial hoof may be smoothed and polished. In this manner many a valuable horse may be rendered useful, which, otherwise, would only remain fit for slaughter. On the score of humanity, also, this application of gutta percha is to be welcomed.

ARTIFICIAL MANUFACTURE OF ICE.

The Paris *Cosmos* thus describes an apparatus invented by M. Carré, and practically operated by him, for freezing water by means of the evaporation of ammoniacal gas.

The generator contains in its lower part, which is called the *boiler*, 190 pounds of an ammoniacal solution at 28°. Under the action of the heat, the ammoniacal gas is disengaged, and passes into a second compartment, which encloses a series of superposed horizontal tubes, with large vertical tubulaors in the middle. This set of tubes performs the function of a rectifier; that is, the gaseous ammonia disengaged by the heat comes in contact in these tubes with the liquid returning to the boiler, gives up to it its vapor of water, and passes to a state of almost absolute purity. From the *rectifier*, the gas passes into a worm, and from this to a *liquefier*, a collection of tubes around which is a current of water, at a temperature of from 53° to 59° Fah. On coming out of the liquefier, the ammonia, now liquid, and still pushed on by the pressure in the boiler, which is some ten atmospheres, enters another vessel called the *regulator*, in which floats a bell with very thin metallic walls, which, by its successive risings and fallings, regulates the discharge of the liquid, and prevents the mixture of any bubbles of gas. Thus condensed, the liquid passes through the induction valve into the *refrigerator*, which is a worm wound several times around the cylinders filled with the water to be frozen, which are placed in a vat of an uncongealable liquid, such as a strong alcohol, or, better, a sufficiently saturated solution of *chloride of calcium (muriate of lime)*.

After resuming the gaseous form, at the expense of the heat of the water in the cylinders, and thus freezing it, the ammonia leaves the worm by a vertical tube, fills a central bottle, and comes into the *absorber*, where it comes into contact with the water exhausted of its ammonia, passing from the bottom of the boiler, and minutely divided by passing through a great number of small holes. There the ammoniacal solution is re-formed, with a disengagement of heat, which is absorbed by circulating again through cold water; finally, from the *asorber*, the ammoniacal solution passes into the boiler by its top, and passes through the tubes of the *rectifier*.

The ice forms very rapidly, and is very solid and opaque; its temperature is about 12° Fah., so that it is not necessary to wait until the water of the cylinder freezes to the centre, as the action goes on after the cylinder is withdrawn. The cylinders are removed every eight minutes, and the ice of each one weighs about nine pounds. With an expense of five and a half pounds of coal burned, there are

obtained fifty-five pounds of ice per hour, and this ratio will increase with the capacity of the apparatus; so that when 200 or 2,000 pounds are made per hour, the price of the ice will not exceed $2.25 per ton.

REFRIGERATOR WITHOUT ICE.

The following is the construction of a novel refrigerator invented by William Simms, of Dayton, Ohio, which is intended to be used without ice.

The principle is that the gaseous vapors from the food are lighter than the atmosphere and septic in their nature. A current of air is passed through the top of the refrigerator to remove these gases. This current may be generated by a lamp, or by a fanwheel running by clockwork for thirty hours. If the tube which supplies the fresh air draws it from near the surface of a well, it will be so cool that it will be unnecessary to use ice.

UTILIZATION OF OLD LEATHER.

A patent has lately been taken out in England for manufacturing a new article to be used for belting, the upper of shoes, and various other purposes for which pure leather has been hitherto employed. The inventor first takes old boots and shoes, belts, etc., cuts them in small pieces, washes them thoroughly in water, and reduces them to a soft pulpy condition by soaking. After this he rolls them out between rollers, dries and mixes them with minute quantities of hemp or flax fibre. They are now intimately united together with a strong solution of glue or gutta percha, then rolled out into bands for belts, or pressed into moulds for the uppers of shoes, or other articles designed to be manufactured from it.

MANUFACTURE OF MALLEABLE HORN.

We learn from *L'Invention* that a patent has been taken out in France, by Messrs. Boulet, Sarazin & Co., for a new process for making malleable horn. The horn, in chips and shavings, is boiled a long time in a caustic lye of strength of 25° of the alcalimeter, by which it is entirely melted. The liquid is then reduced by evaporation to a plastic paste, which may be rolled into sheets, drawn into rods, or moulded in any form. This paste is rendered more strong and elastic by mixing it with India rubber or gutta percha. The substances are mixed together in a cast-iron vessel, and passed between fluted revolving rollers, the vessel being heated by steam. The inventors say that, by covering the fibres of cocoa or of aloes with this paste, they have obtained belts more solid than those of leather, and stronger than those of India rubber.

SUBSTITUTE FOR LINT IN MILITARY SURGERY.

An excellent, cheap, and convenient substitute for patent lint for dressing gunshot or other wounds, is a material which we propose to call *perforated muslin.* It is prepared by simply folding several yards

of muslin many times, and with a small punch and mallet perforating it with numerous holes at a very short distance apart. Much of the substance of the muslin is removed by the punch, and it is rendered sieve-like or reticulated in appearance. It makes an admirable, light and airy dressing for wounds, and several thicknesses may, if necessary, be used to absorb purulent discharges. It has the great advantage for military surgery of cheapness, and ready preparation from materials which can always be conveniently at hand.—*London Lancet.*

WOODEN SUBSTITUTE FOR WHALEBONE.

Many unsuccessful attempts have been made to obtain a perfect substitute for whalebone for the manufacture of the ribs of umbrellas and parasols. A Mr. Ball has found that by selecting the butt end of white oak timber, of what is termed the "second growth," and of straight rib and free from knots or curls, and in no case using more than six feet from the ground or stump, and subjecting it to a certain process of curing, it is made to serve not merely as a substitute for whalebone, but is converted into an altogether superior article, as it is not only tougher and possesses greater tenacity than whalebone, but the ribs made from it always resume their straight condition after exposure to the weather.—*London Chemical News.*

CURIOUS ILLUSTRATION OF THE CAPACITY OF THE LONDON RAILROADS.

A recent English authority states, as an illustration of the rapid expansion of the English railroad system, that while the railroads centring in London in 1851 were only equal to bringing or carrying away forty-two thousand persons daily, they can now actually bring and carry away two hundred and forty thousand visitors; so that the modern Babylon could be emptied of its inhabitants in about ten days.

MACHINE FOR CRYPTOGRAPHY.

Mr. R. A. Brooman, of London, has patented a Cryptographic Machine, or apparatus for carrying on secret correspondence.

The object of this invention is to provide a machine or apparatus by means of which secret correspondence, for diplomatic and other purposes, may be carried on conveniently, and so as effectually to prevent the deciphering of the despatches by any person not in possession of the key to the same. The main feature of the invention consists in the employment of several pairs of alphabets, one alphabet of each pair being capable of longitudinal motion along the other, so as to bring different letters of the two alphabets opposite each other. By arranging the several pairs of alphabets according to positions indicated by means of a "key-word" and a standard pair of alphabets, and transmitting in succession the letters found on one of the two alphabets opposite to the proper letters of the dispatch on the other, the several pairs of alphabets being successively used, a dispatch in cipher may be sent, which dispatch may be readily in-

terpreted by reading the letters of one of the sets of alphabets found opposite to the received letters on the other set; or, in other words, by reversing the sending process. In the machine or apparatus devised by the inventor for these purposes, the movable alphabets are printed or written on endless bands or tapes, which pass round rollers, and may be driven by pinions or otherwise. All the pairs of alphabets are mounted on an axle, which is caused to rotate by a crank handle or otherwise, so as to bring successive pairs of alphabets into view. —*London Mechanics' Magazine.*

GREAT TRIAL OF STEAM PLOUGHS.

An extensive trial of steam ploughs, lasting twelve days, has recently been made at Leeds, England, and the *Mark-Lane Express* gives an elaborate report of the experiments. Most of the work was done by engines stationed at the side of the field, and drawing the ploughs across by long ropes; though it seems there were at last two engines that travelled over the ground. The *Express* concludes that the latter system is impracticable, but that ploughing on the long rope plan may be introduced on very heavy clay soils as a partial substitute for horses.

The engines cost from $2,500 to $4,000 apiece, and the cost of the ploughing ranged from $1.38 to $2.10 per acre. The fastest work was at the rate of about three-fourths of an acre per hour, and the slowest at the rate of an acre in two hours and a half.

The *Express* comes to the conclusion that steam cannot be used profitably in ploughing any land that can be ploughed by two horses at the rate of one and one-half acres per day.

SMOKE FROM GAS LIGHTS.

It is pretty generally imagined that the smoking of ceilings is occasioned by impurity in the gas, whereas, in this case, there is no connection between the deposition of soot and the quality of the gas. The evil arises either from the flame being raised so high that some of its forked points give out smoke, or, more frequently, from a careless mode of lighting. If, when lighting the lamps, the stop-cock be opened suddenly, and a burst of gas be permitted to escape before the match be applied to light it, then a strong puff follows the lighting of each burner, and a cloud of black smoke rises to the ceiling. This, in many houses and shops, is repeated daily, and the inevitable consequence is a blackened ceiling. In some well-regulated houses, the glasses are taken off and wiped every day, and before they are put on again the match is applied to the lip of the burner, and the stop-cock cautiously opened, so that no more gas escapes than is sufficient to make a blue flame; the glasses being then put on quite straight, the stop-cocks are gently turned, until the flames stand at three inches high. When this is done, few chimney-glasses will be broken, and the ceilings will not be blackened for years.

IMPROVEMENTS IN THE MANUFACTURE OF GAS.

Mr. Leslie, a well-known gas engineer of London, proposes to economize the process of gas-making by making it two distinct operations, to be carried on in different localities. The first operation he proposes should be carried on in the immediate vicinity of the mines, where coal is cheap, labor plentiful, and an acre or two, more or less, covered by the works, of little consequence. Here the coal is to be submitted to distillation in the simplest manner, and the product collected in the form of coal-oils; the oil so obtained may then be submitted to purification from the nitrogenous and sulphur compounds which are so fruitful a source of complaint when they find their way into illuminating gas; it being far easier and cheaper, according to Mr. Leslie, to remove all the nitrogen and sulphur from a gallon of coal-oil, than from the one hundred and fifty or two hundred feet of gas of which it is the representative. When the oil has been properly prepared, and purified from all deleterious substances, Mr. Leslie proposes that it should be conveyed to the place where it is needed, and there converted into gas. The works necessary for this purpose need only consist of a few retorts and a gas-holder or two; all the complicated machinery now needed for the purification being rendered unnecessary. The retort being heated to redness, a little of the oil is allowed to flow into it, when instantly it is converted into permanent gas, and carried through a pipe into the gas-holder of the ordinary construction, from which the illuminating gas is supplied to the mains as heretofore. Mr. Leslie calculates that a ton of good coal will yield one hundred and sixty-eight gallons of the hydro-carbon fluid. Now one hundred and sixty-eight gallons is almost exactly one cubic yard, and as each gallon is estimated to yield almost instantaneously one hundred and twenty-eight cubic feet of gas, we have thus twenty-one thousand five hundred and four cubic feet of gas from one hundred and sixty-eight gallons, the material for the production of which only occupies the space of one cubic yard.

The adoption of this plan, Mr. Leslie urges, would render unnecessary the carriage to metropolitan gas-works of an immense quantity of useless material, in addition to the real gas-making constituent of the coal, and also render it unnecessary for gas companies to have large and expensive works in cities, where the process of purification, with its concomitant evil of half poisoning the neighborhood by the sickening odor with which they are surrounded, is obliged to be carried on.

DRESSER'S PROCESS OF NATURE-PRINTING.

The *London Art Journal* for July, 1861, gives the following description of a new process of "nature printing," devised by a Dr. Dresser, an Englishman.

The process is one by which images of foliage may be taken by any who have leisure, and choose to devote an hour or two to the registration of the beautiful forms of our leaves. The process, by its simplicity, commends itself, and the results gained are of the most charming character. The Vienna process of "nature-printing" has achieved

much, and has produced results of the most admirable character; but the process necessitates the use of dried vegetable specimens in order to the production of the image. While this is, at least, no drawback in the case of ferns, and is, perhaps, even an advantage, yet it strongly militates against the process in the case of many other plants. In order to meet this difficulty, Dr. Dresser suggested an "Improved Nature-Printing" process, which he patented, in conjunction with Dr. Lyon Playfair, in which impressions are taken from the living plant, and which may be substantially described as follows: A sheet of foolscap writing-paper should be provided, a handful of fine cotton wool, a piece of muslin, one or more tubes of common oil-paint (according to the color required), a little sweet oil, and a quantity of smooth, soft, cartridge-paper, or, better, plate-paper. Having placed the sheet of foolscap paper, while doubled (the two thicknesses making it a little softer), on a smooth table, squeeze from the tube about as much oil-color as would cover a shilling, and place this on one corner of the sheet of foolscap; now form a "dabber" by enclosing a quantity of the cotton-wool in two thicknesses of muslin, and tying it up so as to give it roundness of form. Take up a portion of the oil-paint from the corner of the paper, with the dabber, and, by dabbing, give the central portion of the sheet of foolscap a coat of color. This dabbing may be continued for half an hour or more with advantage, taking a small quantity more color when the paper becomes dry; *two* or *three* drops of sweet oil may now be added to the paper and distributed by the aid of the dabber, if the color is thick, when the paper will be fully prepared for use.

The paper may be left for an hour or two after being first coated with color without injury, and, indeed, this delay is favorable, for until the paper becomes impregnated with oil, the results derived are not so favorable as they become after the paper is more fully enriched with this material. While the color is soaking into the paper, a number of leaves should be gathered which are perfect in form, and free from dust; and these can be kept fresh by placing them in an earthenware pan, the bottom of which is covered with a damp cloth, but it will be well to place a damp cloth over the orifice of the pan also. Selecting a woolly or hairy leaf, place it on the painted portion of the sheet of foolscap, and dab it with the dabber till it acquires the color of the paint used; this being done, turn the leaf over, and dab the other side; now lift it from the paint paper by the stalk, and place it with care between a folded portion of the "plate" or "cartridge" paper, and if the stalk of the leaf appears to be in the way, cut it off with a pair of scissors; now bring down the upper portion of the folded piece of paper upon the leaf, and rub the paper externally with the finger, or a soft rag, bringing the paper thus in contact with every portion of the leaf. If the paper is now opened, and the leaf removed, a beautiful impression of both sides of the leaf will be found remaining. In like manner, impressions of any tolerably flat leaves can be taken; but harsh leaves will be found most difficult, and should hence be avoided by the beginner. While the paper is yet rich in color, downy leaves should be chosen; but color may at any moment be added, care being always taken to distribute the paint evenly over the paper, with the dabber, before the latter is applied to the leaf,

and the dabber is always renewed from the painted paper till the color is exhausted, when the paper is again replenished from the reserve in the corner.

As the color on the paper becomes less and less in quantity, smoother leaves may be employed; and when the paper seems to be almost wholly without paint, the smoothest leaves will prove successful, for these require extremely little color. Should the natural color of the leaf be desired, it can be got by using paint of the color required; but, in many cases, purely artificial tints produce the most pleasing and artistic results; thus, burnt sienna gives a very pleasing red tint; and of all colors this will be found to work with the greatest ease.

By the process now described, the most beautiful results can be gained; but the effect will be better if, when the impression is being rubbed off, the leaf, together with the paper in which it is enclosed, is placed on something soft, as half a quire of blotting paper. Should the first attempt not prove very satisfactory, a little experience will be found to be all that is required; and now the most common leaf will be seen to have a form of the most lovely character.

Collections of leaves of forest-trees will prove of the deepest interest, or of all the species which we have of any kind of plant; thus, if the leaves of the black, red, American, and golden currant be printed together with that of the gooseberry, all of which belong to one botanical genus or group, the variation or modification of the form will be seen to be of the deepest interest.

IMPROVEMENTS IN THE SCIENCE OF WAR.

The existence of civil war in the United States, and the efforts for a more complete armament on the part of the European powers, have directed the current of invention during the past year very strongly towards the effecting of improvements in warlike implements and preparations, and it is probable that more inventions pertaining to the science of war have been brought out during the past twelve months than during any equal former period of the earth's history. From a multiplicity of facts and suggestions, we present our readers with a resumé of such points as have seemed to us most important and interesting.

IRON-CLAD SHIPS.

The engineering energy of the foremost European nations seems now to be mainly directed to the building of iron-cased vessels of the *Gloire* and *Warrior* type. France has now no less than *fifteen* of these tremendous engines of war; England has *four;* while Russia has recently contracted with English companies for *six.* At the outset, the idea of any iron-cased vessels, whether for steam-rams or frigates, found no favor with the English admiralty, and it was not till the results of French experiments as to the resistance which they offered to shot became known in England, with the additional fact

that their French ally had already commenced to construct several such ships, that the admiralty began to bestir themselves.

The French ship *La Gloire* is built of wood, and completely cased with four-and-one-half inch armor. She is schooner-rigged with three masts, and consequently relies mainly on her steam-power for locomotion. Her stowage is of course very much confined, both as to provisions and to coals, as she has to bear up so much weight of armor. The English iron-plated vessels are very different. While La Gloire is of the size of an ordinary line-of-battle ship of about three thousand tons, the Warrior is a vessel of six thousand tons ; La Gloire is built of wood, the Warrior of iron; La Gloire is cased throughout, the Warrior only partially, both ends being left uncased, and only about half the length of the vessel being protected. Under the 4½ in. plates, (of the latter) which are sixteen feet by four, is a thickness of twenty inches of teak. The rivets are one-and-one-half inch, and extend through the teak into the iron skin of the vessel. She has also a sort of battering-ram in front, which is intended to crush any vessel over which she may desire to pass. Her armament is composed of thirty-six sixty-eight pounders, with two one-hundred-pound Armstrong pivot-guns, and four fifty-pound Armstrong guns.

The trial sea-trips of both the Warrior and the Gloire are reported as completely successful, and, as before stated, both the English and French governments are building or have built other vessels of a similar construction.

The French system of building iron-clad vessels is undoubtedly the cheaper, as the vessel is only half as large as in the English system. The French ships, however, are built of wood, and behind these iron plates it is said that a considerable decay must necessarily take place. But the English vessel has one great advantage. It is now certain that four and one-half inches' thickness of iron armor will not resist the large rifled cannon now in use, and there is no doubt that a well-directed round shot from the fifteen-inch Rodman guns recently constructed by the United States government would crush its way through any iron armor which has yet been applied to the casing of vessels. It may be necessary, therefore, to double the thicknessof the plates applied to these frigates. This can be done on the Warrior, but it cannot be done on La Gloire.

The question whether such vessels shall be cased entirely with iron plates or not is a very difficult one to determine. The English say that ships built for great speed must have very sharp ends, and that if at the same time these ends are armed with heavy plates, speed cannot be obtained in a heavy sea. The French, on the contrary, declare that the unprotected bow and stern of the English vessels can easily be knocked away. This the English attempt to remedy by fitting the ends with water-tight bulkheads.

In addition to the Warrior, the English government have also launched, during the past year, three other iron-clad vessels; one, the "Black Prince," of about the same size as the Warrior, and two others of a smaller tonnage, (viz., three thousand six hundred tons). The cost of the larger vessels was about $1,500,000 each.

In addition to these, Mr. E. J. Reed, in a paper read before the

British Association, Sept. 1861, stated that the construction of six other vessels of a similar character to the Warrior had been entered upon by the British admiralty, three of which would be twenty feet longer than the Warrior, fifteen inches broader, 582 tons additional burthen, and 1,245 tons additional displacement; and as the displacement was the actual measure of the ship's size, they would thus be more than 1,000 tons larger than the Warrior. The cost of these new vessels would exceed the cost of those of the Warrior class by £20,000 or £30,000. They would certainly be noble specimens of war ships. A vessel built throughout of iron, four hundred feet long and nearly sixty feet broad, enveloped from end to end in armor impervious to all shell and to nearly all shot, furnished with the most powerful ordnance, with ports nine feet six inches above the water-line, steaming at the rate of twelve or thirteen knots an hour, would indeed prove a most formidable engine of destruction.

"In vessels of this kind," said Mr. Reed, "all beautifying devices must be dispensed with. Their stems were to be upright, or nearly so; their sterns would also be upright, and as devoid of adornment as the bows. It should also be stated, as a distinguishing mark of these six ships, that their thick plate would not be extended to the bow at the upper part, but would stop at the junction with the transverse plated bulkhead, some little distance from the stem, and this bulkhead would rise to a sufficient height to prevent the spar deck from being raked by shot. They would be armed with fifty one-hundred-pounder Armstrong guns, forty on the main deck, and ten on the upper. The thickness of their armor plates would be six and one-half inches."

The *London Times* of Sept. 23, 1861, in reviewing the trial-trip of the Warrior, thus speaks of her:—

"If the Warrior were merely a floating battery, destined for the protection of a harbor, we might look without much wonder at her prodigious solidity and her impenetrable sides. But the marvel of the case is that a ship with ribs as thick as the walls of Carnarvon Castle, and sheathed in ponderous armor of solid iron, should prove as lively and as buoyant a craft as the lightest yacht that ever floated. It seems probable, indeed, that not even the fastest of our dispatch boats, though built expressly for speed, will rival the speed of this impregnable frigate. She can cleave the waves at a rate of sixteen miles an hour, and can be handled with as much ease as a Thames steamer. Nothing is so calculated to astonish a visitor as the skill with which the incredible strength of this vessel has been combined with apparent lightness and grace of form. The picture given is that of some tremendous floating battery, so tremendous, indeed, that one wonders how it can ever float at all. The reality is a splendid ship, differing from other ships only in size and beauty.

"It is almost overpowering to think of the dimensions of a ship the very engines of which exceed the entire tonnage of an old first-rate Indiaman. We have at length shot ahead of all our rivals, and framed the largest model known. In the last war the Americans got the better of us by building frigates of unprecedented size and solidity, but the finest of them all was but a cock-boat compared with the Warrior. Her construction and trial have upset all our old ideas about 'floating batteries,' for it is plain that a floating battery of

the most formidable powers can be made as light, as handsome, and as nimble as a pleasure schooner. No person, indeed, looking at the Warrior from a little distance, would receive any immediate impression of her strength. To get that it is necessary to go on board, to look through her portholes, with sides and splay like those of an old donjon casement, to measure the dimensions of her engines, and to add up the feet of teak and iron consumed upon her sides. A few hundred yards off nothing of this kind is thought of, and the object before the spectator's eyes is simply a beautifully-shaped frigate, longer than others, more graceful, and apparently faster.

"Our success, then, as far as we can discover, may be said to be complete; but it is dashed with some unpleasant reflections. The cost of these new vessels is tremendous, and we do not know the worst even yet. Ships require docks, and for the whole of our new fleet we have but one dock available. The French, as usual, have taken the lead of us in recognizing their obligations, and are now constructing several docks of the dimensions necessary for the new vessels. Docks, however, are most expensive works, and it is very hard to make them keep pace with ships. It costs little to lengthen a ship, but a great deal to enlarge a dock. It is more than probable, indeed, that we shall require a new establishment somewhere on a scale adapted to the navies of the age."

On the Manufacture of the Iron Plates of the Warrior Frigate.— The London *Engineer* furnishes the following graphic description of the process of manufacturing the iron plates for the Warrior frigate:—

"The tests which were applied to the plates furnished by the builders of the Warrior were of the most trying character. Some plates were fired at with sixty-eight pounders, at two hundred yards range, and were literally cut in halves by balls fired one after another on a line drawn on the surface, each ball striking immediately below its predecessor. Upon some other plates the balls made a circular indentation upon the surface, nearly as deep as the plates, exactly of the form of the projectile, and as though a mould had been taken of it in some soft and yielding substance. It was only after repeated trials that it was decided that the plates should be of annealed scrap iron. The labor involved in building up these plates is enormous. In the first instance, small scraps of iron are thrown into the fire, and when in a state of red heat are subjected to severe hammering, under the steam hammer, until the whole is beaten and amalgamated into a solid mass of about half a ton weight. This lump is then placed on the top of a similar mass, the whole made red hot, and hammered and welded together. Repeated additions of this kind are made, until about five tons of metal are thus welded together in one huge, shapeless body. This is then brought to a glowing white heat, and placed under the huge hammer, the thundering blows of which gradually reduce it into shape. Again and again the enormous slab is put into the furnace, and hammered into one piece of fifteen feet long, three feet wide, and four and one-half inches thick. From ten to a dozen men are engaged in the work of moving these ponderous masses of iron, which are moved about apparently with the most perfect ease. Powerful cranes swing the molten mass from the furnaces to

the hammer; a nicely-adjusted balance is provided by a massive iron lever, one end of which is welded into and forms part of the metal, and this is provided with a dozen or more of horns or handles, by which the iron can be turned in any direction; for the plates are not only hammered on the broad surface, but at the sides and at the top and bottom. The plates, after having been roughly formed into shape, are completely planed and squared. Planing machines of enormous size hug these plates in their resistless arms, and bear them slowly and silently under the sharp cutting edges of the tools, and thin shavings of the metal, which as they are cut coil up in long bright ringlets of iron, attest the tremendous power of these noiseless and all but omnipotent machines. When the edges and surfaces are made perfectly smooth, like the finest work of the cabinet-maker, the plates are placed on an end, gripped firmly by a mortising machine, and, as they travel slowly backward and forward in the frame-work against a small tongue of steel, a groove of about one inch in width and depth is formed, into which the corresponding projections formed on the side of another plate will fit with the most perfect accuracy, the plates all being made to dovetail on each of the four sides."

THE ERICSSON BATTERY.

At the July session of the U. S. Congress an appropriation of $1,500,000 was made for building iron-clad vessels, under a provision that three naval commanders were to approve of all plans before being adopted. The Secretary of the Navy accordingly appointed Commodores Smith and Paulding, and Captain Charles H. Davis to examine and report on the several plans submitted by engineers and shipbuilders. Among others, Captain Ericsson appeared before the committee with a plan of an impregnable battery, which was at once adopted, and the construction of the same was ordered by the Secretary of the Navy, with a stipulation that the work was to be completed within one hundred days from the signing of the contract, viz., October 5th, 1861. There was also another stipulation in the contract of a most remarkable character, and probably without a precedent, viz., the trial of the efficiency of the battery must be made under the guns of the enemy's batteries at the shortest ranges; the United States to furnish guns and ammunition, as well as officers and men. Avoiding as far as possible all technicalities, the leading features of this new battery may be described as follows: — The hull is sharp at both ends, and instead of the gradual curve of a cutwater the bow projects, and coming to a point at an angle of eighty degrees, the sides, instead of the ordinary bulge, incline at an angle of about fifty-one degrees to the vertical line. This hull is flat-bottomed, six feet six inches in depth, and built quite light, of three-eighth-inch iron. It is one hundred and twenty-four feet long and thirty-four feet wide at the top.

Resting on this is another, or upper hull, also flat-bottomed, with perpendicular sides and pointed ends. It is forty-one feet and four inches wide, so that it juts over the lower hull on each side three feet and seven inches. It is one hundred and seventy-four feet long, thus

extending twenty-five feet beyond the hull at each end. The sides are five feet high, and when in fighting order the lower hull will be entirely immersed and the upper one sunk three feet six inches, thus leaving but eighteen inches both fore and abaft above water, the battery drawing ten feet of water. The sides of this upper hull are composed of an inner guard of iron; outside of this is a strongly fastened wall of white oak, thirty inches thick, and covered with an iron armor six inches in thickness. The bottom of this vessel is joined to the hull, so that the interior is open to the bottom, as in a sloop. The deck comes flush with the top of the upper hull, and is bomb proof. First is a frame of oak beams, ten inches square and twenty-six inches apart, covered with eight-inch plank, and protected with two layers of iron, each an inch thick. There will be no railing or bulwark of any kind above the deck.

The ends of the upper vessel projecting over the hull, fore and abaft, serve as a protection to the propeller, rudder, and anchor. The propeller is of course at the stern, and the equipoise rudder behind that, and they are so protected by the upper vessel that they cannot be struck by a ball. The anchor is in front, and is short but very heavy. It is hoisted by a chain running into the hold, up into a place fitted for it, outside of the lower hull, but within the impregnable walls of the upper hull. The inclination of the lower hull is such that a ball, to strike it in any part, must pass through at least twenty-five feet of water, and then strike an inclined iron surface, at an angle of about ten degrees. It is, therefore, absolutely protected, yet so light as to give great buoyancy. A ball striking the eighteen inches of exposed upper hull, to do material damage, must pass through six inches of iron, thirty inches of white oak, and then about half an inch more of iron.

Boarding the vessel, we find that only three things are exposed above the deck, viz., a wheel or steering house, a turret or citadel in the centre, containing the armament of the vessel, and possibly a box around the smoke-escape.

The Wheel-house. — The battery will be steered from the front, and the wheel-house will stand before the turret. It will be of iron, very strong, though during action it is not intended that it should be exposed. It can be lowered into the hold like a bale of dry-goods on one of the ordinary sidewalk falls in use in our great cities. When lowered, the top, which is bomb-proof, is level with and forms part of the deck. The joints are water-tight. The house will be pierced for sharp-shooters.

The Chimneys. — The draft for the furnaces is a forced one, and in action no chimney will be used, as the smoke will pass through bomb-proof gratings in the deck. As the deck will be continually washed by the sea, the accumulation of cinders, etc., will be of no consequence. Probably a small guard will surround these gratings, to prevent heavy seas breaking into them, and a contrivance is made to prevent what water may dash over from going into the furnaces.

The whole vessel thus described is but a bed to support the castle. The turret, which is the important feature of the structure, is a round cylinder, twenty feet in interior diameter and nine feet high. It is built entirely of iron plates, one inch in thickness, eight of them se-

curely bolted on, one over the other, with the joints overlapping each other. Within this there is a lining of iron one inch thick, thus giving nine inches of solid iron. It rests on a bed plate, or rather ring, made of composition, which is securely fastened to the deck. To help support the weight, which is about a hundred tons, a vertical shaft ten inches in diameter is attached and fastened to the bulkhead. The top is covered with forged iron beams and perforated iron, shell proof. The top is perforated to allow the smoke of the guns, and even more, the concussion of the air, to pass off. The top has also some small sliding hatchways composed of two-inch plate iron, to serve as entrance-ways.

The turret has two circular port-holes, three feet above the deck, and just large enough for the mouth of the gun to be run out.

For a contest with iron-clad ships carrying the heavy ordnance recently devised in Europe, Captain Ericsson proposes to dispense with two of the outer plate rings of the turret, and to attach in their place staves of rolled iron four inches thick, thus presenting an aggregate thickness of ten inches of plating, besides the internal skeleton.

The Armament. — The battery will carry two very heavy rifled guns. The carriages, of wrought iron, will run back on iron slides, which are made to fit very accurately. The whole turret, by an arrangement worked by a special engine, is made to revolve; and the operator within, by a rod connected with the engine, is enabled to turn it at pleasure.

In action the guns will be loaded and run out while the portholes are away from the enemy. When ready the turret will be turned as nearly accurate as possible. By nicely adjusted wheels, a very precise aim is quickly obtained, the gun fired, and instantly the turret is turned to bring the gun out of danger. The gun is then drawn in and loaded as before. While one gun is being aimed and discharged, the other is loading, so that almost a continuous discharge can be kept up.

The cylinders of the engines are forty inches in diameter and twenty-two-inch stroke; the boilers being horizontal. It should also be stated, that speed is not a primary object of the builder, the vessel being strictly a battery, and not an iron-clad ship. The blowers for the boilers and for ventilating the ship will be worked by an independent small engine, which will also furnish the power for turning the turret.

This battery, so far as can now be judged, seems to have no vulnerable part, save the port-holes, which are exposed only for about half a minute in firing. Its sharp and massive iron prow will enable it to sink any ordinary vessel with perfect ease. In case it is boarded no harm is done. The only entrance is at the top of the turret, which cannot be easily scaled, and even then but one man at a time can descend. There are no places in the deck where an entrance can be forced, so the boarding party may stay until the sea washes them off, or the sharp-shooters assist their departure.

CAPT. DAHLGREN ON IRON-PLATED SHIPS.

The following letter was addressed to the chief of the U. S. Bureau of Ordnance and Hydrography, under date of December 10th, 1860, by Capt. John A. Dahlgren, U. S. N., the well-known inventor of the "Dahlgren Gun," and other valuable improvements in ordnance. From such an authority the views expressed have much of interest.

SIR, — The earnest attention now given by naval authorities to the armature of ships of war, and the enormous expenditure which England and France are incurring in building ships of this description, induce me to recall the attention of the bureau to the suggestions made by me on this subject several years ago.

In 1852, after a series of practice on the hull of the United States steamer *Water Witch*, principally with nine-inch shell at five hundred yards, I made a report of the facts to the bureau, and in conclusion affirmed the possibility of guarding vessels against the dangerous action of heavy shells. The following passages may be referred to as more particularly applying to this subject: —

"These conclusions, when combined, are suggestive of the following propositions: 1st, that the sides of a vessel may be so protected by iron frames, or plates, as to make it nearly certain that shells will break by impinging thereon. The effect of the explosion will be almost nullified in this way.

"Query: Will the weight of the metallic material so used constitute a serious objection in view of the importance of avoiding the damage that may result from suffering the risk of a large shell's exploding in the frame or about the decks? Experiment will best determine this. 2d. By interposing the coal stowed aboard steamers between the sides and the motive power, there is a very great probability that, in connection with iron ribs or plates on the side, the boilers and machinery may be protected against any ordinary casualty from shells, at least during the period common to sea engagements.

"The formidable power of shells has long engrossed attention, and the tendency to their use is evidently on the increase. If only a moderate portion of their destructive effects be realized, there is every reason to look for more speedy results in sea engagements than have yet been witnessed; and it would be very desirable on many accounts to diminish, if possible, the capacity of this means of offence, particularly as regards sea steamers, the value of which has been materially affected by the liability of their motive power to derangement by projectiles; this consideration has exercised a controlling influence in the character of their armament, which is designed to operate at distances far greater than the pieces ordinarily found in broadside. So far as shells are concerned, even of heavy calibres, I am clearly of opinion that their destructive effects may be nullified, more or less, by the use of iron ribs or plates, and the proper disposition of the coal which every steamer has ordinarily at disposal.

"And if the results here truly represent those which will occur in the average, the motive power of a steamer will be exposed to no greater risk from shells at moderate distances than that of a sailing

vessel, if indeed so much. It remains only to see how far the effects of shot may be neutralized," etc.

The introduction of new and very powerful ordnance by the United States Navy in 1854 undoubtedly led foreign powers to the effort to obtain even more powerful pieces, and the rifled cannon are now about to share a place with the smooth-bores, if they do not replace them entirely. It was natural that the defence should be desired to proceed *pari passu* with the offence, and metallic armature has been adopted. France proposed to build thirty such ships, but was content to begin with ten, in order to correct defects by experience. England is also rapidly endeavoring to meet this emergency at a cost of two and a half millions per ship. The United States must, of necessity, follow where she might have led.

Whether it is best to follow the details adopted for iron-plated vessels constructed in England and France, is by no means certain. The character of their armature, which is the essential feature, contemplates the exclusion of solid shot, which, though not attained in all cases, is yet as nearly effected in the very great proportion of instances as can be useful, while shells, if not entirely neutralized, are rendered of little avail. Now the iron sheathing used on the French vessel, *La Gloire*, for this purpose, amounts to about one thousand tons. Of course the capacity of the vessel to carry ordnance, coals, etc., upon which depends the power of attack, and to keep the sea for any length of time, are proportionally lessened. To decrease this weight, and yet to retain the material defence of the ship, becomes an object; and it is the purpose of this paper to suggest whether the propositions made by me in 1852 may not still contribute to this end. 1st. Use an iron ribbing *externally* with such stowage of coal *within* as the ship permits; using also an interior arrangement of thin plates, calculated to give a harmless direction to projectiles, that is, from vital parts. 2d. These cannot prevent the entrance of shot, but they can be made to nullify shells, either by direct fracture, if round, or by glancing them, if from rifled cannon. 3d. Such armature need not exceed in weight one-half that of the present ship, and thus add some five hundred tons to the capacity for coal, thereby doubling that now carried.

If there should arise any objection to the ribbing not now perceived, then I would recommend that the plated armature be reduced one-half in thickness, which, I apprehend, would not leave the hull open to a dangerous action from shells; for, as I have already stated in "Shells and Shell Guns," the proportion of round shot or shells that glance is very considerable, even on wooden sides, while great force is lost from ricochet. Now, in long projectiles, this is so vastly increased, that it is obviously their weakest point, and can be used well for defence. A very little inclination serves to divert them, and on metal this would be the rule, while the ricochet is so abrupt and so uncertain as to detract largely from their action. This plan would extend the sphere of such ships materially. Now, without sailing power, and relying wholly on steam, it is obvious that they cannot go but a few days from their depots of coal, therefore can only be used in coast defence or cruising along shore.

But these more lightly clad steamers, carrying more coal, and

rising with greater buoyancy on the waves, will go further, and may even, accompanied by squadrons of screw coal-ships, pass to distant seas, and there, by their speed, harass commerce, blockade harbors, and engage the heaviest ships that will venture to assail them.

The project suggested by me in 1852, was to use *ribs*, in connection with such a thickness of coal within as the case permitted; and as round projectiles were alone in vogue, I have no doubt that these, when properly arranged, would have been effectual.

If rifled projectiles are, however, introduced into the batteries of ships, this form of armature will no doubt be less effectual; and I therefore have now suggested the addition of interior plates, so that the projectiles which may reach them shall be diverted from the more vital parts, and in the inner bulkheads of the bunkers can be made to serve this purpose. If, however, the ribbing should be found to be useless against the rifled projectiles, then I propose to substitute a system of smooth plates, *corrugated* or *grooved*, so as to take advantage of the glancing property of the rifled shot or shell.

STEAM-RAMS AS AGENTS IN NAVAL WARFARE.

Admiral Sartorius, of the British Navy, in the following communication to the London *Times*, thus discusses the utility of *steam-rams* in naval warfare: —

As it is clear the iron walls must supersede wooden ones, let us examine which of the two actual arrangements of the former is the most efficient — the steam-frigate iron-cased, with the usual masts, yards, and sails of a line-of-battle ship, only using her guns, or the modification of the steam-frigate, which also uses artillery, and is expressly built for speed and strength, and weight sufficient to sink by concussion, and with a rig subordinate to that important quality. I give my reasons, in the following observations, to show why I think the latter (steam-ram) is infinitely superior for service, less expensive in construction, and much less in maintenance.

The iron-plated steam-ram can make use of guns as the steam-frigate, equal in calibre, and, if required, equal in number. She can use more guns from each extremity than the steam-frigate from her bow or stern; therefore, whether retreating or pursuing, the steam-ram is more formidable, even when she trusts to her guns alone.

A single steam-ram can effect with her beak an amount of destruction in a few minutes which would take many steam-frigates to effect very imperfectly in as many days, if at all. She could get in among a fleet at night, sink two or three ships, and disperse the rest. She could run into a harbor by one entrance, and out by the other, sink some of the ships at anchor in the outer road by her beak, and set fire to others by her incendiary projectiles.

The steam-ram should have both extremities the same; she could run in or out among the enemy's vessels, and advance or back with the same velocity and quickness. If attacking at night, with masts lowered, she could not be seen until felt; could launch out her incendiary projectiles into the town and harbor, and there would be no masts, sails, or rigging to obstruct their flight in every direction.

Guarded by loop-holed and bullet-proof towers, to afford refuge to her people when boarded, and boiling water made to be ejected from them, it would be impossible to take the steam-ram.

No steam-frigate could do all this. A steam-ram, when prepared for action (she has, of course, no bowsprit), with her masts lowered, the rigging, the little she has, frapped in amidships, and without any kind of outside projection, can clear instantly any vessel she may fall alongside of, or that she has run into. If boarded, the boarders must be killed or scalded. As no wreck can hang overboard, her screw cannot be fouled. The steam-frigate, falling alongside of her enemy, and either vessel losing masts and yards, they must get entangled, and their screws fouled by their wrecks; there would then be nothing to prevent a fresh ship from running alongside and effecting an easy conquest of the steam-frigate.

If the steam-ram is constructed with both ends as sterns, she will never require turning in action; she can, therefore, run up or back in passages or rivers as narrow as the breadth of her own beam, and engage batteries at the closest distances. She has two screws to rely upon (she may, in addition, have paddle-wheels), and her screws cannot be fouled from her own wreck. If a steam-frigate, of the rig and dimensions of the *Warrior*, were to run up a narrow channel or river, to engage a battery at close quarters, any wreck from her own guns would infallibly foul her screw. So circumstanced, her great length would prevent her having sufficient space to wear in, as she would require at least half a mile for the purpose, and the embarrassed screw would prevent her from tacking. The velocity of a steam-ram can only be slightly affected by the wind, her schooner rig and lowering masts presenting no comparative resistance when bringing the wind ahead. This position to a steam-frigate, with her heavy masts and yards, might make a difference of several knots an hour, besides much impeding the quickness of her movements.

I have hitherto spoken of the "iron-protected, shot-proof steam-ram." Now, it must be evident to every man acquainted with maritime matters, that when a steam-ram has the superiority in speed and quickness of movement over her enemy, she can make herself equally formidable without shot-proof protection. She can then choose the time and mode of attack most advantageous to her. Such a steam-ram could carry six weeks' or two months' fuel (the screw ships of the day do not carry more than from seven to ten days'); besides, as the aggressive party, she can more easily economize her fuel. She would probably keep out of gunshot during the day, and, making frequent feints, obliging the ships to keep up full steam, the time would soon arrive when their fuel would be expended, and they would become mere sailing vessels. In a dark night, when the steam-ram has all her masts lowered, she uses fuel that emits little or no smoke, and, turning her beak towards her enemy, she becomes invisible to them at two hundred yards; but every movement of the ships, with their high, broad hulls, tall masts, and square sails, is easily visible to the steam-ram. She selects her victim; sixty or seventy seconds after the first cry of the lookout-man, that "the enemy is running down upon us," the five or six bow guns are pouring in their molten iron shells and liquid fire either into the ship at-

tacked or the one ahead or astern of her, and she crushes in either bow, beam, or quarter of the enemy. Every sailor knows that in so short a time it would be impossible to get a large ship to avoid the blow, still less to man, point, and fire her guns at so rapidly-moving an object as the steam-ram, going eight or ten knots. What must be the moral effect, also, upon the crew attacked, knowing that no earthly courage or skill can save them from the inevitable destruction awaiting them in a few seconds!

As the two vessels have different movements (the beak of the steam-ram is made only to penetrate to a certain distance), and the latter immediately backing, she quickly disengages herself, disappears in the darkness, and returns to repeat the same mode of attack. No steam-frigate can do this. The shot-proof steam-ram's most effective mode of attack is when she presents her sharp stem to the enemy and uses her front battery. A shot striking her in that position, it either must glance off the oblique surface, or, hitting the iron plate obliquely, the shot must have double the quantity to penetrate. The steam-ram is safe, therefore, from the artillery of the steam-frigate, the only mode of offence or defence of the latter. The steam-ram, particularly if she has the superiority in speed and quickness of movement, could knock away the masts or bowsprit of the steam-frigate, or disable her rudder by shot, so that, screw-fouled by wreck, or the rudder useless, the steam-frigate must give up or be sunk by the blow of the beak. It is unnecessary to prove that no lateral strength can possibly be given to the steam-frigate which would enable her side to resist the blow or concussion of a vessel, constructed for the purpose, and running into her with the weight and impetus of three or four thousand tons and speed of eight or ten knots, from instantly bursting in her side.

I now answer some objections, apparently well-founded, which have been made to me against using the principle of the steam-ram.

It has been said that if the steam-ram were going at a high speed against a large vessel, the force of the blow or concussion would throw the engine out of gear, and render it useless. This opinion is abundantly refuted by innumerable facts. We hear, unfortunately, almost every day, of steamers, some that have run down other vessels, upon rocks, and going at eleven or twelve knots against stone walls, or into a stone pier, mounting up the stones on either side as if it had been an earthquake, and in every case the engines have never been injured or inutilized until either the bottom has been beaten in by the rocks or the fires have been extinguished by the water rushing in; but the engines have never, and even the stem of the vessel has but seldom, been much the worse for the shock. We must recollect that all these cases of collision or wreck have occurred with merchant vessels of ordinary construction and strength, and as such, therefore, are far inferior in solidity and strength to what the war steamers would be, expressly built and prepared for purposely effecting what has been so often unintentionally done. The beak of the steam-ram rushing upon a large ship with the momentum of three or four thousand tons can never encounter a sudden check; it is the gradual crushing blow, the side yielding to it, the vessel struck heels over, and is more or less driven before the

blow. I am persuaded a man in the gun-room of the steam-ram could hardly know that a collision had taken place. It is again said that the application of the principle of the steam-ram has never been tried. I point out, as my answer, the cases of collision I have alluded to. Every steam-vessel that has destroyed another by running into that vessel is, to all intents and purposes, a steam-ram.

The steam-frigate has only one apparent advantage over the steam-ram, and that will disappear on examination; namely, the line-of-battle ship's masts and sails enable her to make long voyages; but the steam-ram has her five or six schooner masts, and, if required for a long voyage, topmasts, gafftop sails, staysails, and square sails can be added, so that she will spread almost as many yards of canvas as the line-of-battle ship. To resist invasion or protect seaports and harbors, the steam-ram is ten times more serviceable than the steam-frigate or any other description of vessel or shore battery.

RESISTANCE OF IRON AND STEEL PLATES TO PROJECTILES.

In England, no experiments on a very large scale, to determine the resistance of iron and steel plates to the most recently devised projectiles, have yet taken place. The great expense necessary to incur to conduct target experiments on a large scale has had, probably, much to do with the delay. A committee of eminent ship-builders has lately estimated that the cost of a target large enough to test half a dozen modes of construction would be no less than forty-five thousand pounds, and another forty-five thousand pounds would have to be expended in the construction of a floating hull on which to place the target. Several series of experiments, of great interest, have, however, been made by a government commission, of which Sir John Hay was chairman, and Mr. Fairbairn a member. In the first instance, the experiments looked to a solution of the problem as to the superiority of forged or rolled armor plates for iron-clad ships; and the plates used were forged from scrap iron at the government works at Portsmouth dockyard. Each plate, when fired at, was placed in a vertical position against a wooden frame-work. The first plate tried was a 6½-inch, seven feet in length by three in breadth, and weighing 49 cwt. 1 qr. The weapon used against it was the Armstrong gun, with a 126-lb. projectile. The range was four hundred yards. The first shot discharged made an indentation of two inches, with a slight fracture. The second made a like indentation about six inches from the preceding shot, and fractured the plate on its reverse. The third and fourth shots cut pieces out of the plate's edge, and the fifth struck the plate about two feet from its lower edge, and broke it where it had been fractured by the second shot. The next plate put up was a 4½-inch, of the same length and breadth as the 6½-inch, and weighing 35 cwt. 2 qrs. The first shot, discharged from a 100-pounder, at a range of four hundred yards, partially imbedded itself in the plate and remained there. The succeeding shots at this plate were made with the 126-lb. projectile, the first striking the plate in the vicinity of the 100lb. shot, and breaking out a piece of the plate of a triangular form. The succeeding shot fractured the

plate, the cracks radiating, starlike, from the centre. The last shot broke the plate eighteen inches from the bottom.

The next plate tested was a 3-inch, four feet in length by three broad, and weighing 13 cwt. 1 qr., a 40-pounder being used at one hundred yards range. The first shot discharged indented the plate about $2\frac{1}{8}$ inches and slightly fractured it on its reverse. The fourth plate fired at was a $2\frac{1}{2}$-inch, of the same length and breadth as the last, weighing 10 cwt. 3 qrs., at the same range, but commencing with a 25-pounder. The first shot indented the plate $1\frac{3}{8}$ inches, but made no fracture. The second made an indentation of $2\frac{1}{4}$ inches, and fractured the plate on its reverse. The third struck the lower part of the plate but did no damage. The 40-pounder was now pointed at the plate, and its shot tore a passage through. The last plate tested was a 2-inch, of the same length and breadth as the two preceding ones, weighing 8 cwt. 2 qrs. 22 lbs. The range was the same, commencing with a 12-pounder. The first shot indented the plate an inch and a half; the second fractured the plate, part of the shot remaining in it; and the third slightly fractured it. The fourth and last shot was made from the 40-pounder, and passed through the plate.

On another occasion the Committee, in order to ascertain the best quality of material, best thickness of metal, and the best mode of manufacturing iron plates, invited the leading manufacturers of the country to place before them specimens of iron plates which they considered best adapted for the purposes required. Plates, varying in thickness from one-quarter inch to ten inches, were sent in. Sir John Hay, in a report on these experiments, made to the British Association (1861), stated, that the committee found "that the steely description of metal, that was to say, metal which had been hardened, and went by the names of semi-steel, homogeneous iron, etc., up to a thickness of three-quarters of an inch, possessed great resisting powers, but after that thickness this description of metal was not so well qualified to resist a blow of a projectile as wrought iron of the best kind. This having been ascertained, another law had been pointed out to them, which they were not yet in a position fully to recognize. It was, that the resistance of the plating increased with the square of its thickness. Thus, if the resistance of a plate one inch in thickness was equal to one, the resistance of a plate two inches in thickness would be four; four inches in thickness, sixteen; and six inches in thickness, thirty-six. Considerable difficulty was felt in fastening the plates upon the sides of the vessels, as it was felt that all holes drilled in them were a source of weakness. Their great fear was not of a solid missile being driven through the ships' sides, but of the possible material the shot might contain. They could scarcely hope effectually to exclude cold shot, but they did think it was possible so to construct a ship and so to plate it, that a hollow missile impinging upon its sides would be broken to pieces, and consequently they hoped to be able to exclude all shells, red-hot shot, and shot filled with liquid iron, which were amongst the most terrible weapons of modern warfare.

The Committee had also observed that at whatever angle the targets were placed, the fracture made by the Armstrong gun was just

as large, though it differed somewhat in shape, according to the angle. They could only account for this fact by supposing that the damage was done by the instantaneous concussion, and not by the shot boring or punching a hole through.

The Committee also tried experiments with a target composed of iron bars; but they found that the resistance offered was not nearly so great as by the iron plates.

The velocity of this shot from the Armstrong gun was found to be about eleven hundred feet per second.

On the same occasion, in order to test the different plans of iron plating, two differently formed targets were used. One of these was constructed of $\frac{3}{4}$-inch wrought iron placed upon ribs to represent an iron ship, and the shield, five inches thick, was placed directly upon what would be the outer skin of the ship. The other target was made of timber eighteen inches thick, to represent a wooden ship. This was covered with iron plates three inches in thickness, of angular form, like a wide letter V.

In both cases, the plates were found practically shot-proof, but the fastenings gave way by which the plates were secured to the target. The plates were fastened to the iron target by rivets passing through the skin and entering the plate, like tapped screws, to the depth of an inch and a half. These screws were nearly all broken by the shots. The 3-inch plates were fastened to the target by $\frac{3}{4}$-inch bolts eighteen inches apart. These bolts were the first things to yield in this target. It was found also that when the plates were broken the fracture generally commenced at a bolt-hole.

In another instance, an experimental vessel, called the "Trusty," was covered with thick iron plates, and exposed to solid shot from Armstrong's and Whitworth's rifled ordnance. On the first day four shots were fired at four hundred yards' distance with Armstrong 80-pounders, and each broke the plating so as to expose the inner lining of wood. The fifth shot did not penetrate; the sixth was a bolt of puddled steel, weighing eighty-eight pounds; it penetrated the plate, and passed in a slanting direction to an upper deck beam, where it was broken into several pieces. Ten shots were fired at this distance, two of which missed, but all the others broke the outer plates, yet did little damage to the interior lining.

On the second day's firing, the distance was two hundred yards, with an Armstrong 100-pound iron conical bolt for the three first shots. The first started a plate half an inch at one end; the second fractured a plate the whole of its length; the third struck a joint and passed completely through the plates, opening the joint three-fourths of an inch. The fourth was a bolt of homogeneous metal (fine steel) weighing eighty pounds. It struck the started joint of the plates, passed through it, struck an iron knee, tore it away, and drove a piece of the iron plate into the water-way on the opposite side. The next shot was a 100-pound bolt of homogeneous metal. It forced in a piece of plate nineteen inches long and seventeen inches broad, to a depth of eight and one-half inches. Nine shots were fired, one of which missed. They either broke or greatly damaged the plates, but the inner planking of oak, twenty-five inches thick, was little injured.

Only four shots were fired by Whitworth's gun. Each bolt was formed of homogeneous metal, hexagonal in form, flat-headed, and weighing seventy-nine pounds. The first passed through the iron plating four and one-half inches thick, and buried itself eleven inches within the wood behind. The second passed through both the plating and the thick timber lining inside, carried away part of an iron knee, and drove a piece of the outer plating half way across the ship. The third shot passed through one of the ports. The fourth cracked a plate, pierced it, and destroyed part of the upper deck water-way, but it did not enter into the ship.

It was found that the second shot of the Whitworth cannon, which was the only one which penetrated into the inside of the ship, passed through part of a plate that was unsound, and the wood through which it entered was also defective. Whitworth's cannon had the greatest penetrating power.

From these experiments, with the most powerful rifled guns and solid shot, at two hundred yards' distance, $4\frac{1}{2}$-inch iron plates, having a thick backing of wood, afforded immunity from danger to those on board, although the plates were greatly injured by the firing.

The effect of Armstrong's 120-pound gun, tried against 10-inch plates, is thus described: "The target consisted of a shield of iron, the plates dovetailed, backed with massive timber, and braced with iron bars. The 68-pounder made no impression on this bulk, but when it was submitted to an Armstrong projectile of 126 pounds, the destruction was instantaneous. The first shot, at a range of six hundred yards, cleaned out one of the 10-inch plates, at the same time carrying away the back support. The next gun fired was one of the ordinary 100-pounder Armstrongs, with a solid projectile weighing 110 pounds. The battery was struck in another part, and a breach was made clean through the structure, the fabric itself being so weakened as to insure destruction. The third shot, with the same weight of projectile, was directed against another part of the battery, and the result was conclusive, as the whole fabric of the battery, already weakened, came down above the point that was struck."

With regard to the ultimate effect of artillery against ships protected by defensive armor, Sir William Armstrong unhesitatingly gives his opinion, "that whatever thickness of iron may be adopted, guns will be constructed capable of destroying it." The best ordnance officers of the United States army are also of the opinion that no vessel, however thickly plated with iron, can resist the crushing effect of the immense guns (400-pounders) which they are endeavoring to introduce into our sea-coast fortifications.

Inefficiency of the Armstrong and Whitworth Guns.—Mr. W. Bridges Adams, an eminent English engineer, who has given much attention to the subject of iron-plated ships and the use of heavy rifled ordnance, in a recent communication to "*Once a Week*," uses the following language:—

"After all that has been said of the damaging power of the Armstrong and Whitworth guns against armor plates, it has been stated that the most mischievous weapon is the service 64-pounder of 8-inch smooth bore. There are obvious reasons for this result, and one chief reason probably is, the friction of the rifles, which diminishes the ve-

locity of the shot. Sir Charles Napier, of Scinde, was accustomed to say that the smooth bores had not been given a fair chance. There is little doubt of this, and the time will come when the children of a future generation will ask why soldiers were called riflemen, and the answer will be, because the guns were contrived with one defect to compensate for another."

THE ANGULATED PRINCIPLE OF SHIP-BUILDING AS A PROTECTION AGAINST HEAVY ORDNANCE.

It is well known that if a shield of any kind be struck at an angle or on a slant, the sword or bullet glances off, and the force of the blow is destroyed. Targets in all times have been "sloped" accordingly. Shields were made convex, either tapering to a point in the centre, or rounded off at the sides in the form of semi-cylinders. Cuirasses took the same form, sloping away from the middle like the breast of a fowl, so that no shot could strike full upon the plate. To take advantage of this principle, Mr. W. Jones, an English engineer, proposes to construct iron-plated ships with sloping sides; or, in other words, to use the same armor plates as already adopted, but, instead of placing them vertically, so as to present an upright wall of metal, to place them at an angle, so that a sloped face only is offered, like the slant of a parapet. To test this device, some experiments were made in August last (1861), under the direction of the British Admiralty.

A target, representing the sides of a ship, composed of timber-work twelve inches thick, and covered with iron plates $4\frac{1}{2}$ and $5\frac{1}{2}$ inches thick, was constructed, and fired against with an Armstrong gun, carrying a bolt twelve inches in length and seven inches in diameter, and weighing one hundred and ten pounds. The London *Times* makes the following remarks in regard to the experiment:—

"It happened that everything was favorable to the accuracy of the experiment. The gun was one of the heaviest in use, throwing a bolt of one hundred and ten pounds, the very kind of projectile which had smashed the Shoeburyness butts into fragments. The firing took place at two hundred yards' distance, and the practice was most perfect. The shots hit the target so truly, that if it could have been penetrated at all they must have pierced it. Six bolts actually struck the armor within a space of twenty-one inches by twelve, and three of these fell within an inch or two of the same spot. Thus the critical test of a succession of blows at the same point was thoroughly applied, and it does not seem, indeed, as if any shield could ever have been battered with more tremendous force. The effect produced, however, was comparatively insignificant. The last shot of all, though lighting just on the track of the others, and giving, as it were, the last blow to the work, failed to penetrate the armor; and, as a general result, it was found that, though no fewer than sixteen shots had been planted more closely together than could ever be expected under ordinary conditions of practice, the plates were not pierced, nor was the wood-work materially injured. The final shot, says the report, fell on Nos. 15 and 3, carrying away the armor plates in irregular pieces between shots 15, 22, 3, 21, 11, 7, crushing

the surface of the 12-inch wooden backing, but not in any way breaking through the same, or damaging the shell of the vessel in the slightest degree.

"Such results certainly seem to open a new system of ship-building, for we do not see how it is possible to qualify them or explain them away. The attack had the fairest possible chance. The shots of the most powerful piece of ordnance in use were delivered one after another with extraordinary accuracy, and yet we are assured that they failed in reaching the wood-work through the iron plating. It follows, therefore, that if there should be no other objection to Mr. Jones's principle, we have found a way of making men-of-war shot-proof. It deserves to be mentioned that the iron plates were of peculiarly good manufacture, and they appear also to have been set on to the wood-work in a judicious fashion, but the essence of the device consists, of course, in the shape or angle given to the face of the armor. The next question, then, is, whether such a slope is compatible with the sea-going qualities of a ship; whether a vessel built with sides falling in at an angle of fifty will answer in all other respects as well as in her power of resistance to shot. That is a point which we shall probably see discussed. It has been said that such a vessel would be washed over by the waves and drenched like a half-sunk rock at high tide. It has also been urged, and with obvious plausibility, that a high-sided ship, ranging alongside such a craft, and firing down upon her, would strike her armor plates no longer at an angle, but point-blank, so that the charm would be broken.

"If, however, these objections can be refuted or removed, we may perhaps see our ships of war assuming the form which we have delineated above, and of which models have been constructed already. Sails and masts would probably be dispensed with, and reliance placed upon steam alone. The vessel lying low in the water, with her single tier of guns, and her low sides sloping off like the roof of a house, would offer no mark to an enemy, and, indeed, would hardly be a visible object at a little distance. The change would be exactly analogous to that which took place in fortification after the discovery of gunpowder. Instead of strong towers and massive walls, the new system introduced sunken walls and low parapets of sloping turf. The principle of defence consisted in exposing no surface to attack. A fort in a flat country was scarcely visible. Citadels of the first order, and capable of sustaining a six months' siege, could only be distinguished by a few low embankments from the meadows around them. Just so will it be with ships if the new principle should prevail. The poetry of the old idea will be lost. There will be an end of lofty masts, swelling sails, and graceful hulls. A ship will no longer be a splendid compound of strength and beauty, sitting the waters like a bird. She will be a terrible machine of destruction, invisible till she suddenly discloses herself, and as impregnable to all attacks as a submarine rock. The conflict of two such vessels would be like the conflict of two catamarans. A man-of-war, in short, would be reduced to the simplest form of a floating battery, moved by steam. The only object of the builder would be to cover a certain number of Armstrong guns with an impenetrable shield, to make the fabric float in water, and to propel it at the quickest possible rate.

The new British cruiser would be an armed raft under an iron tortoise-shell.

MISCELLANEOUS NOTES ON MILITARY MATTERS.

On the Influence of Rifled Ordnance on Modern Warfare.— Commander Scott, an authority on gunnery in the British Navy, in a recent lecture, remarked that battles had generally been decided at close quarters, and ever would be; and although artillery had now acquired longer ranges by rifling the guns and using elongated shot, the change was merely one of degree, not of system. The modern improvements in ordnance will not materially influence the distance at which actions will be fought and decided. Sir William Armstrong long ago stated, in a paper to be found in the "Transactions of Civil Engineers," that "the real struggle would always be within a distance of two thousand yards; and the great object should be to make weapons as destructive as possible within that limit."

Com. Scott asserted that at short distances no elongated shell had yet surpassed a 68-pounder ball, and as the round ball caused incomparably less strain on the gun, and could be loaded more rapidly than an elongated shot, the latter should be abandoned for short ranges. He asserted that the best and most economical course for the British government to pursue in arming the navy, was to rifle all the smooth-bore cast-iron and brass guns in the arsenals and dockyards, use elongated shell for long distances, and finish the action with round shot at close quarters.

Is the Armstrong Gun a Failure?—The London *Mechanics' Magazine* maintains that the Armstrong gun has proved a signal failure; an opinion which, it states, has been fully confirmed by all the recent experiments with it. Its defects are as follows:—

In the event of firing as rapidly as the necessities of warfare may require, heat is rapidly transmitted to the mass of the gun, so that the delicate screw arrangements and breech pieces no longer fit into each other as before. So readily does this change take place that before the thirtieth round has been fired the piece becomes useless; even an enormous escape of gas is noticed before firing the twentieth round. The pressure of this gas on the vent-piece is such that it exceeds the cohesive strength of any known material of which guns are made; and hence the vent-pieces are either broken into fragments or bent so completely out of shape as to render the gun unserviceable.

The Magazine further states that during one series of experiments made recently by the admiralty committee, no fewer than *nine* pieces were thus destroyed on a single gun, which was thus rendered useless until it could be repaired. In another case fifty rounds destroyed four of those pieces, *requiring eight hours* to replace them and make the necessary repairs. At this rate of going, the gun could in effect fire only one shot in sixteen minutes!

Still another objection to the use of this invention arises from the composition of the shot and shell, which consists of iron coated with lead. Each forms, consequently, when exposed to moisture, *a regular voltaic pile.* Hence it is found that in a short time the lead exfoliates from the ball, owing to atmospheric influences alone. The transpor-

tation of those missiles in such a condition is alleged to have cost considerable loss of life to the English army in the late Chinese war.

The London *Engineer* also uses the following language: —

We shall have greatly mistaken if we are not now near deliverance from the five-years' delusion of the so-called "Armstrong gun." In actual range it has been exceeded by Mr. Lynal Thomas's rifled gun; in penetrative power, at short range, it is notoriously inferior to the ordinary cast-iron service guns, throwing a projectile of even less weight; in cost it is very far more expensive than any other gun, even when made of bronze or of steel, and in the essential qualities of reliability in action it would appear, from all the experiments that have been made, that it is inferior to any and every gun yet produced. As for great range, say beyond three miles, there is no advantage that any one can assign. But even if ten-mile ranges were desirable, it would require only that the gun employed should be able to withstand proportionate charges of powder, exploded behind long projectiles of comparatively small diameter. Given an unburstable gun, and almost any range under twenty or thirty miles would be practicable. Long range, with a given form and weight of projectile, is solely, however, a question of so many pounds of powder and of the strength of the gun. Powder is so cheap that, so far as its cost is alone concerned, it is almost immaterial what quantity be used, and as for the other and far more important condition, — strength of gun, — it is sufficiently known that the Armstrong gun in no way approaches to the greatest practicable strength. Captain Halsted, in a letter to the *Times*, states that the Stork gunboat has had no less than four 100-pound Armstrong guns in succession, the first, second, and third having failed, one after the other.

New Spanish Rifled Cannon. — From a recent report published by the Spanish government, it appears that their Ordnance Board, after trying various kinds of breech-loading guns, with lead-covered shot like those now in use in England (the Armstrong system), have decided on using muzzle-loading rifled cannon, made with a core of cast iron, hooped with wrought iron; a plan known as that of Capt. Blakey. These guns are advertised in the English papers, with either steel or iron cores, at very low rates: 12-pounders for $150, and 200-pounders for $2,000. The shell used in these guns is entirely of cast-iron, except six buttons of zinc, which enter the grooves of the gun, and give rotation to the shell. As may be supposed, the exact angle for the grooves, the exact length of the shot, and position of the buttons best adapted for service, were not ascertained without many trials. At last, however, great certainty of aim seems to have been attained, to judge by the published tables of firing.

On the danger of rifling the present stock of cast-iron cannon, the Spanish board say: —

"Cast-iron by itself, as is clearly proved to us by the bursting of the guns we have tried, is not strong enough to resolve the question of rifled cannon of large calibre, unless the charge of gunpowder be much reduced, and even then the gunners would not feel confidence in their guns."

Wrought-iron guns, forged in one mass, the board also condemn. Their final decision, which has been acted on by the government, to

the extent of ordering the construction of six hundred 60-pounders, is in the following words:—

"The path we must follow is clearly indicated: cast-iron cylinders, hooped, a most simple manufacture, which, once established, only requires great care in securing the proper diameter to the bore of the hoops."

The reports from which we derive our information contain detailed accounts of experiments with breech-loading cannon, but of none which gave satisfaction to the artillery committee. The lead-coated shot they declare to be uncertain in aim, in consequence of the difficulty of always securing exactly the same difference between its diameter and that of the bore of the gun.

An exceedingly interesting experiment is reported to test the powers of the new rifled field and siege guns. The fortress of Molina de Aragon was breached in three places by an old smooth-bored 24-pounder, by a $4\frac{8}{10}$-inch rifled gun, and by a $3\frac{4}{10}$-inch rifled gun. The former opened a breach eleven yards wide, in the ten feet thick wall, in one hundred and seven rounds, requiring ten hours. The second made a similar breach in two hundred and twenty-two rounds, in fifteen hours; and the third in eight hundred rounds, in forty hours.

Taking into consideration the much greater facility of moving the lighter rifled guns than the heavy smooth-bore 24-pounder, the commission unanimously recommend the use of the medium rifled gun for siege purposes.

On the Elongated Cannon Projectiles used by the U. S. Government.—In the present war, five varieties of elongated projectiles have been used by the artillery of the United States army, viz., the "James," "Hotchkiss," "Sawyer," "Parrott," and "Shinkl" shot. The two first have been already noticed in previous volumes of the *Annual of Scientific Discovery* (see vols. 1859, 1860); the others may be briefly described as follows:—

The *Sawyer Shot* is of cast-iron, finished in a lathe, then coated with tin to secure the adherence of a covering of lead or pewter. It is then placed in a very accurate mould, and lead or pewter is cast round it, forming wings, which fit and fill the grooves very nearly. This shot will, of course, fit only the gun having the same number of grooves, and cannot avoid windage; while in loading it care must be taken to enter the wings into the grooves of the gun.

The *Parrott Shot* is cast on a shallow wrought-iron, which forms the base of the missile, the action of the powder driving the edges of the cup into the grooves. It may be fired from any gun except a bronze one, which would not resist the wear of the wrought-iron against the corners of the grooves, and even cast-iron or steel could not long endure the enormous friction.

The *Shinkl Shot* is a plain iron shot with oval front and conical rear, on which a wad of *papier mache*, or similar substance, is forced by the powder explosion spreading into the grooves.

Filling Shells with Molten Iron.—Further experiments have recently been made at Woolwich, England, on the use of shells filled with molten iron. A number of gun-carriages, platforms, and men formed of wood, representing artillery-men, were arranged about a

battery, and a shower of these molten iron shells were fired at them, from a distance, by a 68-pounder. The effect is represented to have been terrific; the shells consumed everything upon which they fell. Three hundred new cupolas, for melting iron for these shells, have been furnished at Woolwich for distribution among the batteries on the British coast. Each cupola consists of an outer shell of plate iron lined with fire-brick, and a fan-blower is used for each, as in all our iron-foundries. The driving-gear of the fan is so constructed that whenever steam-power is available it can at once be applied. When the blast-fan is driven by manual labor, eighteen men are required to work it, with short reliefs. In about twenty minutes after the fire in the cupola is lighted the iron is put in, and in about a quarter of an hour after the fan has been put in motion the molten iron can be run off into the shells. A ton of metal can be melted in about thirty minutes. Allowing, therefore, for waste, the number of shells that can be filled in one hour is one hundred and forty of the eight-inch 68-pounders, and the same number of the ten-inch 96-pounders. The estimated weight of the machine is five tons.

Open-work Rifled Cannon. — One of the most singular devices relative to the construction of ordnance is a cannon invented by Mr. De Brame, of New York. This gun is a breech-loader, the breech having six chambers; but the barrel, from the trunnions to the muzzle, is formed of bars placed some inches asunder, and rifled inside, and held in place by outside rings, also some inches apart, leaving the barrel open for the air to pass through. The bars direct the ball as accurately as if the barrel were solid, while the free ventilation secured prevents the gun from becoming unduly heated.

In answer to the objection which would naturally occur to any one experienced in the use of firearms, that by leaving the barrel open much of the expansive force of the powder would be lost, Mr. De Brame states that in experiments made with two models — one in which the barrel was covered and the other not — he had found that the projectile would issue with at least as great force from the latter as from the former.

Terry's Breech-loading Carbine. — The British government have recently adopted for use in the cavalry a breech-loading rifled carbine, known as Terry's, which has the following peculiarities: —

The barrel is twenty-four inches in length, — full length thirty-seven and a half inches, — and weighs altogether a trifle under six pounds. It has an effective range of over a thousand yards, is sighted for 1,200 yards, and will carry a ball or rifle shell 1,500 or 1,600 yards, or very nearly one mile. The bore is the same as the Enfield rifle, and fires a similar bullet, — conical, — one weighing about an ounce. The contrivance for loading and then closing the breech is one that sends a steel plug into the lower end of the barrel about the third of an inch. The ball protrudes naked from one end of the cartridge, and when fired entirely fills the bore and grooves, thus preventing windage. It is impossible for it to leak fire. By a singular and ingenious contrivance in the cartridge the gun lubricates and cleans itself, and does not become the least foul, even after firing thousands of times. At the lower or base end of the cartridge is a wad, cut out of heavy woollen felting, at least a quarter of an inch thick. This is

saturated with grease, lard, or tallow. The powder is between this wad and the bullet, and after the discharge the wad remains in the gun. Of course the wad goes out before the next bullet, and as the gun grows warm by firing, the grease melts, and the gun is lubricated and cleaned out at every discharge. One of these rifles was fired eighteen hundred times in succession without cleaning or examination, under the inspection of some officers at Portsmouth, and was then pronounced clean and in as good condition as when the experiment commenced. It missed fire just twice in the eighteen hundred discharges. Terry's breech-loading rifle was invented six or eight years ago, and has now the enviable distinction of being exclusively used by the British cavalry, hussars, dragoons, and mounted riflemen, and the only breech-loader in use in the British army and navy service.

Patterson's Improved Gun Lock.—Mr. Juan Patterson, an engineer attached to the steel works of Messrs. Corning, Winslow & Co., Troy, N. Y., is the inventor of a new method of firing a piece of ordnance by means of a friction tube, or lock set in the *cascabel*, or knob at the breech of the gun. The cascabel, instead of being permanently attached to the breech of the piece, is set into it by means of a screw, and thus in reality the bore extends the entire distance of the gun, so that when the cascabel is taken off one can look directly through the gun. By means of a spring, the cap is exploded by the lock, and the gun discharged. The advantage of this means of discharging an ordnance piece of this character by a lock set into a detached cascabel, is, that in case it is necessary to retreat in an action, and the gun cannot be brought off, the lock can be unscrewed in an instant, and be carried away. The gun is thus disabled, and cannot be turned upon the retreating body. Spiking a gun in such an event is entirely unnecessary in Mr. Patterson's mode of firing it.

New Mortar Cannon.—The London *Times* thus describes a new French invention:—The tube or barrel is formed of several cylinders or rings of cast or wrought iron. The interior of the tube is rifled by means of a certain number of projecting spiral rods shaped in triangular prisms. The tube can be lengthened at pleasure. The breech of the gun is a mortar, to which the tube is attached, and from which it may be detached, either for the puropse of loading it at the breech, or of making use of it as a mortar. It is alleged that this cannon cannot become heated, and that the process of cleansing after each discharge is unnecessary, except as regards the breech. Another consequence said to follow from the non-heating of the barrel of the gun is, that there is no danger of bursting, either from defect in the metal or from over-charge. The gun may likewise be lengthened or shortened at pleasure. The inventor states that a gun throwing a shot of one hundred and twenty pounds' weight may be taken to pieces and conveyed on the back of a horse or mule over roads impassable for carriages. He shows that there is a considerable saving in the construction of this gun in consequence of the tube being of open-work, and of iron, in place of bronze. It may be as light as is consistent with the resistance which its weight must necessarily oppose to the recoil produced by its discharge. The inventor expects that this gun will supersede mortars, and that every cannon mounted

on a ship's deck may be used both as a cannon and a mortar, and that a ship which carries forty guns may be said to carry forty guns and forty mortars.

Trial of the great "Rodman" Gun.—The great 12-inch rifled cannon, constructed according to the plan devised by Lieut. Rodman, U. S. A. (see *Annual Sci. Dis.* 1861, p. 50), for the government, has been mounted during the past summer at Fortress Monroe, and thoroughly tested. This gun is sixteen feet long, weighs fifty-two thousand pounds, and carries a solid shot weighing four hundred and twenty-three pounds. The N. Y. *Tribune* gives the following spirited description of the firing of this monstrous piece of ordnance:—

"First, the swab, which two men insert, cleans the interior; then comes a man with a red flannel bag filled with powder on his shoulder; it is the cartridge; and the ramrod, worked by four men, sends it home. Then comes the process of getting the shot to its place, a mass of metal that four men carry with difficulty. It is first rolled into an iron cradle or wide strap, looped with a rope, through which a piece of strong wood, several feet long, is inserted. Thus slung, the men tug the shot up the steps of the platform, some ten feet high, to the mouth of the gun. Another lift brings it on a level, and it is slid into the muzzle and pushed to its place. The gun is then elevated by means of an iron bar, the gun being nicely balanced on its trunnions. The priming wire performs its office, the fuse is inserted, and the lanyard is attached. 'Ready,' says the sergeant; 'Ready—fire!' says the lieutenant. A terrific crash, a sheet of flame, and the trembling of the earth, follow. At the same time there is a screech and a scream caused by the shot, a black mass which you can see, in its flight, yelling like an infuriated devil let loose from the infernal regions."

The results of the practice with this gun demonstrate its complete success, and it is probable that government will order their construction in considerable numbers for our sea-coast fortifications. In its ranges for shot and shell, it does not exhibit any decided advantages over those obtained from the 10-inch gun, up to 10° elevation; but beyond this elevation the gain is considerable, and may be estimated at about 600 yards for the elevation of 28° 35′. With 39° elevation, and a charge of forty pounds large-grained powder, it is probable a range considerably beyond four miles might be attained. Indeed, the conviction appeared to be general among the officers who witnessed the firings, that the gun could, if necessary, bear much heavier charges, though, for all ordinary uses, it is doubtless best to keep them down to somewhat less than the above.

The Chronoscope.—This name has been given to a recent English invention, which is intended to measure accurately the time of the flight of projectiles. It consists, in the first place, of a barrel, revolving by clockwork, which is cased with paper, upon which four or more pencils trace a continuous line. These pencils are in communication with a voltaic battery and electro-magnetic apparatus, and the targets, made of fine crossed wire, which may be four or more in number, according to the pencils, are placed 200, 300, 500 or 700 yards apart. When the shot strikes the first target, the current is broken

and one of the pencils stops marking, and so on with the remaining targets; and by means of a pendulum the records are reduced to figures, which give the initial velocity of the shot, at various parts of its flight, which is of the utmost importance, as it includes the resistance of the air, and affords practical data for the most correct calculations through larger flights. The resistance of the air has always been estimated from certain known laws, but now it may be determined by practical experiments. It is not expected that the instrument will register correctly beyond seven hundred or one thousand yards.

Illustration of the Movement of Projectiles in Vacuo. — The following is a description of an invention by Col. Fox, of the British army, intended to demonstrate the parabolic theory of projectiles in vacuo. The initial velocity being taken at 107 yards per second, a bar is provided with movable wires and beads at the extremities, the length of which increases as the square of the times; on placing the bar, which represents the plane of the direction of the shot, at any required angle, a beautiful parabola is produced. The instrument shows at any elevation the range of the projectile; for example, at 20° elevation the range is 700 yards, at 30° 920 yards, 45° greatest, when it registers 1050 yards. If the angle is still further increased, the range diminishes in proportion, showing that forty-five degrees is the maximum elevation for the greatest range. The apparatus is also capable of showing the range of a shot when fired down from an eminence with depression; and a parallelogram arrangement is adapted to the parabolic curves, to prove that they are the result of a compound force.

The Nyctoscope. — Sir W. Armstrong has described to the London Institution of Civil Engineers the principle of the Nyctoscope, an ingenious instrument designed by him for enabling the gunners to maintain a fire upon any given object after nightfall. The principle of the instrument is to render a false object in the rear, or at one side, visible upon a vertical line in a mirror, when the gun is laid upon the true object. A lamp attached at night to the false object becomes visible upon the same mark in the mirror, when the gun is in line with the true object. The vertical adjustment for elevation is effected by a spirit-level clinometer, forming part of the instrument.

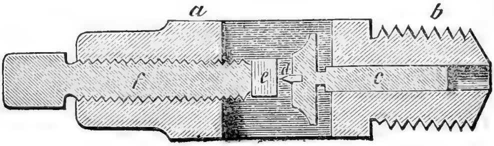
RODMAN'S EXPERIMENTS IN GUNNERY.

It is perhaps well known to many of our readers that there has been in progress for several years a series of costly experiments (instituted by the U. S. War Department) to determine the best form and material for cannon, and the qualities desirable in gunpowder. These experiments have been conducted, for the most part, under the direction of Capt. T. J. Rodman, of the ordnance department, U. S. A., and by him have been recently published in an illustrated volume.

Some of the most interesting facts developed by these experiments, and set forth at length in the volume above referred to, are in relation to the pressure in a cannon, at the time of its discharge, exerted by the gases resulting from the combustion of the powder. To meas-

ure this pressure an instrument was devised, which is illustrated in the accompanying engraving.

A hole about a third of an inch in diameter is drilled through the wall of the gun to the bore, and the outer portion of this hole is enlarged to receive the end of a cylinder, *a*, which has a piston working within it. In the cut, *b* represents the portion of the cylinder



which is screwed into the hole in the cannon, and *c* is the piston, corresponding in size to the smaller portion of the hole. The gases, pressing on the inner end of the cylinder, force it outward. Its outer end is armed with a steel point, *d*, which is forced into a copper bar, *e*, to a depth depending upon the amount of the pressure. The copper bar and steel point are then placed under massive steelyards, and the force required to produce an indentation equal to that produced by the gas is accurately weighed. Capt. Rodman says that a difference of two pounds in 30,000 is plainly perceptible; "so that the indications of this instrument may be *safely* regarded as approximating to within 1,000 pounds of the true pressure, even for the greatest pressures exerted, and much nearer for the smaller pressures."

We give some of the most interesting results obtained:—

Pressure per square inch due to Proof Charges in a 42-Pounder Gun.

	Pounds.
21 lbs. powder, 2 shot and 1 wad, gave a pressure at the bottom of the bore	64,510
14 lbs. powder, 2 shot and 1 wad, gave a pressure at the bottom of the bore	55,622
21 lbs. powder, 1 shot and 1 wad, gave pressure	47,785

Table showing the velocity of shot, in feet per second, and pressure of gas per square inch, in pounds, due to equal columns of powder behind equal columns of metal, when fired in guns of different diameter of bore, each result being a mean of ten fires.

Pressure different at distances from bottom of bore.

Diameter of bore.	Weight of charge.	Weight of shot.	Velocity.	At bottom.	At 14 in.	At 28 in.	At 42 in.	At 56 in.	At 70 in.	At 84 in.
7	5.13	74.44	904	36,420	15,850	8,370	6,470	6,850	8,050	6,720
9	8.48	124.42	888	67,100	21,100	17,750	14,900	29,475	20,970	22,825
11	12.67	186.03	927	86,750	29,300	27,800	22,420	28,400	33,850	25,050

Constant Weight of Projectile, and Increasing Charges.

Weight of Charge.	Pressure per Sq. In. Pounds.	Wt. of Charge.	Pressure per Sq. In. Pounds.
3	11,319	8	24,146
4	17,483	9	28,972
5	16,983	10	32,638
6	18,811	11	37,463
7	19,551	12	38,961

Constant Weight of Charge with increasing Weight of Projectile.

Weight of Charge. Pounds.	Weight of Projectile. Pounds.	Pres. Square Inch. Pounds.
5	35	16,733
5	40	17,563
5	45	24,226
5	50	27,323
5	55	28,632
5	60	34,966
5	65	32,797
5	70	34,886
5	75	36,964
5	80	38,462
5	85	41,120

"The points most worthy of note in these results are the very marked increase in pressure of gas as the diameter of bore increases, and that the indications of pressure are greater at 56 inches, 70 inches, and 84 inches than at 42 inches, especially in the 9-inch and 11-inch guns. The cause of the difference of pressure developed in these guns of different diameters of bores is believed to be mainly due to the great heat developed by the combustion of the larger mass of powder in the large than in the smaller calibre; and perhaps, also, to the different products of combustion formed under this increased temperature and pressure, and partly to the greater cooling surface in proportion to the weight of charge in the smaller than in the larger calibre."

The highest pressure observed in a cannon was 100,000 pounds to the square inch, but this was greatly exceeded in a shell. A very strong shell was cast; the exterior diameter being twelve inches, and the interior a little less than four, with an orifice only one-tenth of an inch in diameter, this orifice being the only outlet for the gas. The cavity was filled with powder, which was fired, when the instrument indicated a pressure of 185,000 pounds to the inch.

The following are some of the conclusions to which Capt. Rodman was led by experiments which we have not space to describe in detail:—

"Time is required for the rupture of any mass of iron, though the rupturing force may be greatly in excess of the resistance of that mass. And in the ordinary discharge of cannon the gun is subjected at each discharge to a force which would inevitably burst it, if permitted to act for any appreciable length of time; so that it may be said that cannon do not burst because they have not time to do so before the bursting pressure is relieved."

"Pressure increases in a higher ratio than that of the volume of powder; it being, for the larger charges, almost as the squares of the volumes."

INTERESTING EXPERIMENTS WITH GUNPOWDER.

When ordinary small-grained powder is burned in a cannon, the combustion is so rapid, and the gases are consequently so quickly developed and so highly heated, that an enormous pressure is produced at the breech of the gun before the ball starts from its seat; then, as the gases expand, the pressure is rapidly reduced, so that the velocity of the ball is small in proportion to the maximum pressure exerted upon the gun. It occurred to Capt. T. J. Rodman, of the Ordnance Department, U. S. A., that if the powder were made to burn a little more slowly, the pressure would be less at the breech, and would follow up the ball with more force during its passage out of the gun, thus giving greater velocity to the shot with less danger of bursting the cannon.

The first plan that he tried for producing a slower combustion of the powder was to make it in large grains, which were compressed with great force, so that they could not be permeated by the gas, and, consequently, could burn only by a gradual combustion commencing on the outside and extending inward. Powder of the same quality in every respect, except the size of the grains, was prepared by the Messrs. Dupont, the grains in one sample being all three-tenths of an inch in size, those of another four-tenths, of another five-tenths, and of the last six-tenths. Capt. Rodman made a series of fires with this powder in a 11-inch gun, using the same weight of charge, 12.67 lbs., and the same cylindrical shot, weighing 183.3 lbs., at every fire. Five fires were made with powder of each size of grain, and the mean results are exhibited in the following table:—

Diameter of Grain.	Velocity of Shot.	Pressure of Gas, in pounds,		
		At bottom of bore.	At 14 inches.	At 28 inches.
.6	933	21,370	10,350	8,030
.5	932	21,210	11,170	7,300
.4	881	25,590	10,750	7,300
.3	890	35,330	10,710	6,680

The smallest-grained powder, three-tenths of an inch in size, produced a pressure at the bottom of the bore of 35,000 lbs. to the square inch; which was reduced to 6,700 lbs. at 28 inches from the bottom of the bore, giving a velocity to the shot of only 890 feet per second; while the powder of largest grain, six-tenths of an inch in size, though producing a pressure of only 21,000 lbs. at the bottom of bore, followed it up with 8,000 lbs. at 28 inches, and gave a velocity to the shot of 933 feet per second.

The granular form, however, is not the best for cannon powder, whatever the size of the grains. In order to give the greatest possible velocity to the shot, with such degree of pressure as may be safely employed, the pressure against the shot should continue nearly uniform throughout its passage from the gun. It should be exactly uniform were it not for the fact that a less pressure will burst a gun if

applied to its whole length than is required to burst it if applied to only a portion of its length; hence the pressure should diminish as the shot recedes from the breech, but not nearly as rapidly as the experiments show that it does diminish even with the largest-grained powder.

As the shot starts very slowly at the breech, and moves with constantly accelerated velocity in its course through the bore, in order to make the pressure uniform throughout, the gases should be evolved from the burning powder with a corresponding acceleration. But if the powder is granular the combustion commences on the surface of the grains and proceeds inward, constantly reducing the grains, and, consequently, the extent of the burning surface. Thus the rapidity with which the gases are evolved is retarded instead of being accelerated. Capt. Rodman conceived that if the powder was formed into hollow cylinders, to be fired wholly from the inside, the burning surface would be enlarged as the combustion progressed, and, consequently, the rapidity with which the gases were evolved would be accelerated. In order to confine the combustion to the interior of the cylinders, he moulds them together into octagonal cakes, from one to two inches in thickness, which are perforated with small holes.

The cakes are submitted to a powerful pressure in a cylinder, the plunger being armed with wires to form the holes. In practice, the axes of the cylindrical holes are parallel to that of the bore.

Capt. Rodman says that the increasing rapidity of the evolution of gas may be regulated so as to give any pressure desired along the bore, by establishing the proper relation between the number and diameter of cylindrical holes, and the thickness of the walls between them.

"The initial burning surface, and the ratio of the maximum to the mean pressure, may also be varied by varying the number and thickness of the cakes in a given weight of charge; the initial burning surface and the maximum pressure both increasing with the number of cakes, since the burning surface extends over the whole surface of the cakes.

"The thickness of walls between the cylinders should be such as to be burned through, or consumed, before the projectile leaves the gun; and for ordinary velocities we should economize in weight of charge, by making the walls of such thickness as to burn through by the time the projectile has traversed two-thirds or three-fourths of the bore, and allowing the gas to act expansively from there to the muzzle.

"It will readily be seen, from the foregoing, that this form of cartridge gives us entire control over the rate of combustion of the charge — a fact the importance of which can hardly be overrated; for, taken in connection with the hollow mode of casting cannon, it removes all limit, as regards safety, to the calibre, of which even cast-iron guns may be made." — *Scientific American.*

DOREMUS'S COMPRESSED POWDER.

The idea has been suggested by Prof. R. O. Doremus, the well-known chemist of New York, that gunpowder for projectile purposes

may, in most cases, be used with as great advantage in the form of compressed cylindrical cakes as in grains; and experiments instituted under his auspices by ordnance officers of the U. S. Army have given most satisfactory results. Most persons would unhesitatingly assert that gunpowder compressed in a hydraulic press, to a consistency so hard as to resist fracture on being struck violently, would burn when ignited in the manner of a fuse, or slow-match. Such, however, is not the case, as the compressed cake explodes on the application of fire, with *apparently* as great rapidity as loose grains. The idea of using compressed powder, if found practically available, is one of the most useful of recent improvements in military science, inasmuch as it entirely obviates the necessity of a cartridge, — either cannon or musket, — reduces the bulk of the powder two-thirds or more, and saves the waste consequent on transporting and handling powder in grains.

NATURAL PHILOSOPHY.

THE REPULSIVE FORCE AND THE RESISTING MEDIUM.

M. Faye's examination of Plana's Memoir on this profound subject appears in a recent number of *Comptes Rendus* of the French Academy (No. 7). The discussion relates to the very basis of natural philosophy, involving the explanation of the highest astronomical and meteorological phenomena. The celestial world does not obey one force alone — attraction, but a duality of forces — attraction and repulsion. The first depends on the mass alone, the second on the surface and the heat. The former is propagated instantaneously and through all matter, the latter successively, being easily intercepted by a medium. But both forces are universal. They are found wherever there is heat and mass — in the systems of the most distant stars, and in all the bodies which we can touch; in all phenomena which arise in experimental philosophy and the arts.

ELECTRICITY OF THE ATMOSPHERE.

The origin of the electricity of the atmosphere has long occupied the attention of physicists, and at different times they have apparently settled down on some plausible hypothesis, which merely offered a probable explanation of the phenomena, without leading to new facts or pointing out new lines of research.

The earth, as is now well known, is almost a perfect conductor for the most feeble currents of electricity, provided the contact with it of the electrified body be sufficiently broad. The aërial covering which surrounds it, however, is a non-conductor, which is capable of confining electricity in a condition of accumulation or of diminution, and of preventing the restoration of the equilibrium which, without the existence of this insulator, would otherwise take place.

The hypothesis was at first advanced that the earth attracted the ethereal medium of celestial space and condensed it in a hollow stratum around the whole globe; that the electricity of the atmosphere was due to the action of this exterior envelope. Dr. Hare, our countryman, has presented this hypothesis with considerable distinctness. Without denying the possibility or even probability of such a distri-

bution of electrical excitement, we may observe that, if this electrical shell were of uniform thickness (and we see no reason to suppose it should vary in different parts in this respect), it would follow, from the law of central forces, that it could have no effect in disturbing the equilibrium on the surface or in the interior of the earth; a particle of matter remaining, as we have seen, at rest or unaffected at any point within a hollow sphere. This fact appears to militate against the truth of this assumption.

Another hypothesis attributed the electricity of the atmosphere to the friction of the winds on each other and on the surface of the earth; but careful experiments have shown that the friction of dry air on air or of air on solids or liquids does not develope electrical phenomena.

The next hypothesis was advanced by Pouillet; which referred the electricity of the atmosphere to the evaporation of water, particularly that which contained saline ingredients. But when pure water is carefully evaporated in a space not exposed to the sky, no electricity is produced except by the friction of the sides of the vessel in the act of rapid ebullition; and when the experiment is made with salt water, the electrical effects observed are found to be produced by an analogous friction of the salt against the interior of the vessel. When pure water is evaporated under a clear sky, the vapor produced is negatively electrified; but this state is contrary to that in which the atmosphere is habitually found.

Pouillet also supposed that the process of vegetation was a source of disturbance of the electrical equilibrium, but this has not been supported by critical experiments.

The discovery accidentally made, a few years ago, of the great amount of electricity evolved in blowing off steam from the boiler of a locomotive, seemed to afford a ready explanation of the electrical state of the atmosphere. It was then attributed to the condensation of the aërial vapor. Faraday, however, conclusively proved, by one of his admirable series of model experiments, that this effect was due entirely to the friction of the water which escaped in connection with the steam on the side of the orifice through which the discharge took place. When dry steam, or that which is so heated as to contain no liquid water, is blown out, all electrical excitement disappeared; and when condensed air, even at elevated temperatures, was discharged from an insulated fountain, no electricity was produced.

The celebrated physicist of Geneva, Professor De la Rive, refers the electricity of the atmosphere to thermal action. It is well known that if the lower end of a bar of iron, or of any other metal not readily melted, be plunged into a source of heat, while the upper end remains cool, a current of electricity will flow from the heated to the cooled end, the former becoming negative and the latter positive, and that these different states will continue as long as the difference of temperature is maintained. Now, according to Professor De la Rive, a column of the air is in the same condition as the bar of metal — its lower end is constantly heated by the earth, and its upper cooled by the low temperature of celestial space. Unfortunately, however, for this ingenious hypothesis, a column of air is a non-con-

ductor of electricity, while a bar of metal is a good conductor, and it still remains to be proved that such a distribution of electricity as that we have described relative to the bar of metal can be produced in a column of air.

The foregoing are the principal hypotheses which have been advanced to account for what has been considered the free electricity of the atmosphere. After an attentive study of the whole subject, we have been obliged to reject them all as insufficient, and compelled, in the present state of science, to adopt the only conclusion which appears to offer a logical explanation of all the phenomena, namely, that of Peltier, which refers them not to the excitement of the air, but to the inductive action of the earth primarily electrified.

The author of this theory, we are sorry to say, did not receive that attention which his merits demanded, nor his theory that consideration to which so logical and so fruitful a generalization was justly entitled.

Peltier commenced the cultivation of science late in life, and, since the untutored mind of the individual, like that of the race, passes through a series of obscure and complex imaginings before it arrives at clear and definite conceptions of truth, it is not surprising that his first publications were of a character to command little attention, or, indeed, to excite prejudice, on account of their apparent indefinite character and their want of conformity with established principles. His theory of atmospheric electricity requires to be translated into the ordinary language of science before it can be readily comprehended, even by those best acquainted with the subject, and hence his want of appreciation may be attributed more to the peculiarities of the individual than to the fault of the directors of the science of the French Academy.

According to the theory of Peltier, the electrical phenomena of the atmosphere are entirely due to the induction of the earth, which is constantly negative, or what, in the theory of Du Fay, is called resinous. He offers no explanation, as far as we know, of this condition of the earth, which, at first sight, would appear startling, but, on a little reflection, is not found wanting in analogy to support it. The earth is a great magnet, and possesses magnetic polarity in some respects similar to that which is exhibited in the case of an ordinary loadstone or artificial magnet. This magnetism, however, is of an unstable character, and is subjected to variations in the intensity and in the direction of its polar force. In like manner we may consider the earth as an immense prime conductor negatively charged with electricity, though its condition in this respect may, like that of its magnetical state, be subject to local variations of intensity, and perhaps to general as well as partial disturbance. It may be said that this merely removes the difficulty of the origin of the electricity of the atmosphere to an unexplained cosmical condition of the earth, but even this must be considered an important step in the progress of scientific investigation. The hypothesis of Peltier has, since his death, been rendered still more probable by the labors of Sabin, Lloyd, La Mont, Bache, and others, in regard to certain perturbations of the magnetism of the earth, which are clearly referable to the sun and moon. It must now be admitted that magnetism is not

confined to our earth, but is common to other, and probably to all, the bodies of our system; and, from analogy, we may also infer that electricity, a coördinate if not an identical principle, is also cosmical in its presence and the extent of its operation. That the earth is negatively electrified was proved by Volta at the close of the last century. For this purpose he received the spray from a cascade on the balls of a sensitive electrometer; the leaves diverged with negative electricity.

This experiment has been repeated in various parts of the globe, and always with the same result. That it indicates the negative condition of the earth, is evident when we reflect that the upper level from which the water falls must be considered as the exterior of the charged globe, and hence must be more intensely electrified than points nearer the centre. Since the earth is, as a whole, a good conductor of electricity, as shown by the operations of the telegraph, the electrical tension of it cannot differ much in different parts, and we are at present unacquainted with any chemical, thermal, or mechanical action on land of sufficient magnitude to produce this constant electrical state. We are therefore induced to adopt the conclusion that the earth, in relation to space around it, is permanently electrical; that perhaps the ethereal medium, which has been assumed as the basis of electricity, as was supposed by Newton, becomes rarer in the vicinity and within bodies of ponderable matter. Be this as it may, all the phenomena observed in the atmosphere, and which have so long perplexed the physicist, can be reduced apparently to order, and their dependences and associations readily understood, in accordance with the foregoing assumption. This is not a mere vague supposition, serving to explain in a loose way certain phenomena, but one which enables us not only to group at once a large class of facts which from any other point of view would appear to have no connection with each other, but also to devise means for estimating the relative intensity of action, and to predict, both in mode and measure, changes of atmospheric electricity before they occur. It follows, as a logical consequence from this theory, that salient points, such as the tops of mountains, trees, spires, and even vapors, if of conducting materials, will be more highly excited than the general surface of the globe, in a manner precisely similar to the more intense excitement of electricity at the summit of a point projecting from the surface of the prime conductor of an ordinary electrical machine.

It also follows, from the same principle, that if a long metallic conductor be insulated in the atmosphere, its lower end, next the earth, will be *positive*, and the upper end *negative*. The natural electricity will be drawn down by the unsaturated matter of the earth into the lower end of the wire, which will thence become redundant, while the upper end will be rendered negative, or under-saturated. That this condition really takes place in the atmosphere was proved in a striking manner by the experiment of Guy Lussac and Biot, in their celebrated aërial voyage, which consisted in lowering from the balloon an insulated copper wire, terminated at each end by a small ball. The upper end of this was found to be negative, and consequently the lower end must have been positive, since the whole apparatus, including the balloon, was insulated. The experiments should be re-

peated at different elevations by some of our modern aëronauts, since the results obtained would have an important bearing on the theory of atmospheric electricity. — *Prof. Henry, Report of Smithsonian Institution*, 1859.

ELECTRICITY GENERATED BY EVAPORATION.

Mr. Palmieré, in a note in the *Cosmos* (Paris), states that in order to obtain electricity by condensing vapors, he had some water in a capsule of platina, not insulated, made to boil slowly. He collected the vapor upon a platinum refrigerator, at a height of about two feet above the surface of the water, and by means of a condensing electroscope soon convinced himself that the vapor manifested positive electricity. Encouraged by this result, he next sought to discover the negative electricity in the capsule of platinum which contained the water in a state of vaporization. Having isolated the capsule, and put it in connection with a condensing electroscope, he concentrated the solar rays on the distilled water in the capsule by means of a lens about a foot in diameter. He thus obtained a superficial ebullition, hardly visible, and also indications of negative electricity in the capsule. He afterwards varied the mode of experimenting, and operated on different liquids.

WHAT IS HEAT-LIGHTNING?

The flashes of lightning often observed on a summer evening, unaccompanied by thunder, and popularly known as "heat-lightning," are merely the light from discharges of electricity from an ordinary thunder-cloud beneath the horizon of the observer, reflected from clouds, or perhaps from the air itself, as in the case of twilight. Mr. Brooks, one of the directors of the telegraph line between Pittsburg and Philadelphia, informs us that, on one occasion, to satisfy himself on this point, he asked for information from a distant operator during the appearance of flashes of this kind in the distant horizon, and learned that they proceeded from a thunder-storm then raging two hundred and fifty miles eastward of his place of observation. — *Prof. Henry.*

EXPLANATION OF CERTAIN FAMILIAR ELECTRICAL PHENOMENA.

After the introduction of furnaces for heating rooms by warm air, the public were surprised at exhibitions of electrical excitement which previously had not been generally observed. If our shoes be very dry, and we move over the surface of a carpet, with a shuffling motion, on a very cold day, particularly in a room heated by a furnace, the friction will charge the body to such a degree that a spark may be drawn from the finger, and under favorable circumstances a jet of gas from a burner may be ignited. There is nothing new or wonderful in this experiment; it is simply an exhibition of the production of electricity by friction, which only requires the carpet, the shoes, and the air to be dry — conditions most perfectly fulfilled on a

day in which the moisture of the air has been precipitated by external cold, and its dryness increased by its passage through the flues of the furnace. In the ordinary state of the atmosphere, the electricity, which is evolved by friction, is dissipated as rapidly as it is developed; but in very cold weather the non-conducting or insulating power of the air is so much increased that the electricity, which is excited by the almost constant rubbing of bodies on each other, is rendered perceptible. Every person is familiar with the fact that, on removing clothes or shaking garments in dry weather, the electricity evolved by the rubbing exhibits itself in sparks and flashes of light. The popular idea in regard to this is that the atmosphere at such times contains more electricity than at others; but these appearances are not due to the variation of the electricity in the atmosphere, but simply to the less amount of vapor which is present. When the clothes are rubbed together, one part becomes positive and the other negative, and in dry air the excitement increases to such an intensity that the restoration of the equilibrium takes place by a visible spark; but in the case of moist air the equilibrium is silently restored as soon as it is disturbed, and no excitation is perceptible.

Similar effects are observed on the dry plains of the western part of our continent; in rubbing the horses or mules, sparks of electricity may be drawn from every part of the body of the animal. Persons in delicate health, whose perspiration is feebly exhaled, sometimes exhibit electrical excitement in a degree sufficient to surprise those who are not familiar with the phenomena. But these exhibitions have no connection with animal electricity, and are merely simple illustrations of the electricity developed by friction in an atmosphere too dry to permit the usual immediate and silent restoration of the electrical equilibrium. — *From an article entitled "Atmospheric Electricity," contributed by Prof. Joseph Henry to the Report of the Smithsonian Institution*, 1859.

LIGHTNING FIGURES.

It is often stated that tree-like figures have been found on the bodies of men and animals struck by the electric fluid. In 1857, M. Andreas Poey, of the observatory at the Havana, brought the subject under the notice of the British Association. He stated, among many other cases, that in August, 1853, a little girl was standing at a window before which stood a young maple tree, "a complete image of which was found impressed on her body after a flash of lightning." The subject has been recently examined by Mr. C. Tomlinson, of King's College, who has contributed a paper on it to the *Edinburgh Philosophical Journal.* He gives an account of experiments, during which he discharged a Leyden jar on plates of window-glass previously breathed on, whereby various tree-like figures were produced, and in a wood-cut he exhibits one exceedingly like a gnarled oak. His theory is that the impressions referred to above are produced by the figures which the lightning itself assumes in striking the earth, etc. M. Poey would refer their production to photography, in which the lightning is the efficient agent instead of the sun. M. Baudin proposes a new term for the branch of science

which is to include them, viz., keraunography, from *keraunos*, Greek for thunder.

NEW PROCESS OF REFINING IRON AND STEEL BY INDUCED ELECTRICITY.

At a recent meeting of the Franklin Institute, Mr. A. L. Fleury, of Philadelphia, gave some account of a new process attempted by him for refining iron and steel by induced electricity.

After noticing the well-known fact that we are able, through the decomposing power of electricity, to destroy the chemical affinity by which certain substances are united, he stated "that Sir Arthur Wall, of England, was the first who used galvanic electricity for the purification of iron. Some twelve years ago he fully demonstrated the value of electricity as a refining agent, and had it not been for the trouble, expense, and danger connected with his process, it would doubtless have found a speedy introduction. Mr. Wall used a large number of Smee's batteries and polar platina plates, in order to precipitate the positive impurities on the negative pole while the metal was in its melted state, in a manner similar to the ordinary galvanizing process."

Mr. Fleury's experiments had been made with a view of simplifying the process devised by Mr. Wall.

"The use of the now celebrated Ruhmkorff's induction coil (an apparatus not yet discovered at the time when Mr. Wall secured his English patent) presented some new and different effects from those of the ordinary galvanic battery. While the galvanic current destroys the old and produces new chemical affinity, the interrupted secondary current simply destroys the same, without producing the before-named effect of the continuous current. Before describing my experiments with induced electricity, I have to digress to another subject, which, though it may seem somewhat abstract, is still closely connected with the same.

"Wherever we notice a cellular or fibrous texture in organized matter, we invariably find the presence of nitrogen. In the plant as well as in the animal fibre, nitrogen appears as the most necessary constituent. Why should not nitrogen have something to do with the fibrous condition of metals? The celebrated chemist, Fremy, in Paris, has lately proved beyond a doubt, that nitrogen is a necessary constituent of steel. I may perhaps succeed in proving that nitrogen is also necessary for the formation of the tenacious fibre in iron and other metals. I simply mention here this abstract idea because it seems to be somewhat connected with the experiments which I come now to describe."

Mr. Fleury then gave an account of a series of practical experiments he had undertaken, with a suitable induction apparatus. One of the most successful was upon a lot of old cast-iron, of which nine hundred pounds at a time were placed in a double puddling furnace, without cinders, and heated to the usual degree. The broken secondary electric current was passed through the heated metal from side to side by means of two platina points, for about ten minutes only, during the stage of fermentation — the so-called "coming to nature"

of the iron. At the same time I introduced some nitrogenized hydrogen in the form of a small quantity of carbonate of ammonia. The heat seemed to increase considerably, and the electricity passed in dense multiplied sparks from side to side. I found by several successive experiments that the impurities of the iron, freed from their former combination, boiled up, and, meeting the nitrogenized hydrogen, were carried off, either as volatile cyanides, or in various hydrogen combinations, leaving a fine fibrous iron in the furnace.

The iron, after having been balled, was passed through the well-known Bordan's squeezer, rolled, *without re-heating*, into plates, and finally cut into nails. This would give to the manufacturer a saving of about five dollars per ton.

NEW KIND OF ELECTRIC CURRENT.

When pure water flows through a porous body, an electrical current is elicited; a fact established by experiments, says M. G. Quincke, which may be stated concisely in these terms:—

Some thirty layers of thin silk stuff were placed over each other and attached over one tube of the apparatus; another tube was then adapted against the former, and the part separating them covered thickly with sealing-wax. Owing to the wide pores of the silk, considerably more water flowed through, under equal pressure, than when the clay plate was employed. The linen was used in the same manner.

The other substances were applied in the form of powder, in a glass tube of the diameter of the above tubes. The ends of these tubes, the length of which varied, according to the substance employed, from twenty to forty-five millims., were ground flat, and over them were placed disks of the silk stuff spoken of, to prevent the flow of the fluid carrying away particles of the substance under examination. In the case of Bunsen's coal, the tube was closed with plates thereof.

Platina was made use of in the spongy form, iron as filings. The glass had been reduced to powder on an anvil. Ivory and the various kinds of wood were employed in the form of sawdust. It was endeavored in vain to press water through a porous plate of wood, for the plate had to be luted in dry; and on becoming moist, even if cut perpendicular to the direction of the fibres, it warped so much that it broke the sealing-wax or the tube.

The direction of the electric current was not changed by adding acids or solutions of salts to the distilled water, but it was considerably weakened thereby.—*Poggendorff's Ann.*

FORMATION OF THE GREEN MATTER OF LEAVES UNDER THE INFLUENCE OF THE ELECTRIC LIGHT.

M. Hervé Mangon, of Paris, has published the results of some experiments made by him, with a view of ascertaining whether the green matter of leaves, etc., would be formed when a plant was submitted solely to the influence of the electric light. It is well known that a plant grown in darkness is devoid of green color, and it is

generally considered that the sun's light is essential to its development. From M. Mangon's experiments, however, it appears that the electric light is equally capable of inducing its formation.

The electricity was produced by an electro-magnetic machine worked with a steam-engine. The light was obtained from a lamp with charcoal points. On the morning of the 30th July, several flower-pots, each containing four grains of rye, sown respectively on the 24th, 26th, 27th, and 28th of July, were placed in a large space, perfectly secluded from external light, the pots standing about one metre from the electric lamp, and half a millimetre below the point of light. By the 2d of August all the plants had developed as well as if they had been in the open air, and all exhibited their natural green color. On the third of August the experiment was brought to an end. It is scarcely necessary to add that some corresponding seeds grown in darkness for the same period were perfectly yellow.

It follows from the above, that the electric light, like sunlight, is capable of causing the development of the green parts of plants. It has been previously shown that the light resulting from very intense combustion, such as results from pyrotechnic compositions, for instance, is capable of producing the same effect.

ELECTRICAL MEMORANDA.

In September, 1861, the beautiful experiment was made of illuminating the famous Falls of Schaffhausen on the Rhine, thirty yards in height, by means of five electric lights. The effect is said to have been marvellous, especially when viewed through colored glasses; the waves of the river resembled a sea of fire.

Electric Light applied to Surgery. — One of the greatest obstacles to the success of a surgical operation is the scanty and imperfect light which, in some cases, is the surgeon's only guide, and is fraught with danger to the patient. Thus the extirpation of a naso-pharyngian polypus is performed in almost absolute darkness, it being impossible to bring a common light near enough to the patient without scorching him. The problem, therefore, of finding a light which might be introduced into a cavity with impunity, remained still to be solved; and, from a communication sent in some months since to the Academy of Sciences, by MM. Th. Doumoncel, Foussagrives, and Ruhmkorff, it would appear that this desirable object has at length been attained. Dr. Foussagrives, having long entertained the idea that the electric light might be advantageously applied to the purpose, communicated his views to M. Doumoncel, a distinguished electrician, who, calling to mind the effects of electricity *in vacuo*, as exemplified in Giessler's tubes, which, although traversed by the electric light, reveal no increase of temperature, conceived the following plan for turning this circumstance to account in surgical cases of the nature alluded to. A glass tube, having a very small bore, is bent into the form of a helix or screw (the smaller the bore the greater the brilliancy of the light): by this means a kind of luminous cylinder is formed, which is sufficiently small to be conveniently introduced into a narrow cavity Thus the first part of the problem was solved; but the color of the light was yet to be determined, since this depends on the nature of

the gases introduced into the tube. As mixtures of certain gases, such as carburetted hydrogen, carbonic acid, hydro-chloric acid, etc., will produce a white light, nothing remained but to fill the tube with such a mixture; and this delicate operation was entrusted to M. Ruhmkorff, who at the same time introduced other valuable improvements into the apparatus. The latter has since been fairly tried in various dental and other operations.

Curious Electrical Phenomena.—Mr. Gore, of Birmingham, who has been for some time engaged making researches into the movements of liquid metals and electrolytes in the voltaic circuit, has made the following interesting discovery. If a large quantity of electricity be made to pass through a suitable good conducting electrolyte into a small surface of pure mercury, and especially if the mercurial surface be in the form of a narrow strip about one-eighth of an inch wide, strong vibrations occur, and symmetrical crispations of singular beauty are produced, accompanied by definite sounds at the mutual surfaces of the liquid metal and electrolyte.

A new Electrometer has been invented by Mr. Thomas Sate, for measuring the electrical charge of the prime conductor of a machine, and is described by him in the *Phil. Magazine.* It is termed the siphon electrometer; and stated to be sufficiently delicate and reliable in its indications; and to admit of being constructed so that the results derived from one instrument may be fairly compared with those derived from another instrument. It depends on the principle that different quantities of electricity discharge different quantities of liquid from a siphon-tube in which the liquid is suspended by capillary action. A glass jar, containing water, about four inches in diameter, is placed upon an insulating stand of gutta-percha; a small siphon about .15 of an inch diameter is cemented to the side of the jar. A funnel-shaped receiver, about three inches in diameter, is connected with the ground by a damp cord, and placed directly below the orifice of the tube, and connected with a glass tube divided into tenths and hundredths of a cubic inch, and a conducting wire is fixed to the prime conductor of the electrical machine and drops into the liquid. The instrument is used in the following manner: a sufficient quantity of water is poured into the jar, so as to cause the siphon to act; the water then flows through the siphon until its pressure in the jar is balanced by the capillary action of the tube, when it will cease to flow. It will then be found that the level of the water in the jar stands somewhat above the orifice of the siphon-tube. Scarcely any amount of shaking or oscillation will now cause the water to flow from the orifice. The graduated tube is then placed below the orifice, the bottom of the funnel being from two and one-quarter to two and one-half inches from this orifice. The machine is then turned, and the electric action causes water to flow in a continuous stream or jet from the orifice, filling the tube. Any proposed number of revolutions being given to the machine in a known time, the number of cubic inches of water discharged is taken as the measure of the efficiency of the machine.

The Duration of the Electric Spark.—The duration of the electric spark which accompanies the discharge of a conductor is the subject of a note by Professor P. Rijhe, of Leyden, in the *Biblio-*

thèque de Genève. When the discharge of a Leyden jar takes place the duration of the spark is considered to be of so short a space of time as to be inappreciable. Professor Wheatstone found that the sparks which he obtained by employing a copper wire the fifteenth of an inch in thickness and half a mile in length had a duration of about the 24,000th part of a second. He also showed that to pass over that space the electricity travelled at the rate of the 1,152,000th part of a second. To explain this he had recourse to a hypothesis, and proposed to admit that the diameter of the wire was not large enough to permit the charge of the Leyden jar to traverse it otherwise than in a successive manner. After mature reflection and experiment, Professor Rijhe believes that he has found a more simple explanation, which he puts in the form of the following proposition: the space of time which electricity requires to traverse a conductor is much less than that which the discharge of the same conductor requires.

An Electric Spark of Induction produced by Ruhmkorff's great machine at Paris has pierced through a plate of crown glass nearly two inches thick, and another about one inch and a quarter thick. These plates were recently laid before the Academy of Sciences by M. Faye, who stated that such thick plates had never before been pierced by the spark of induction. The holes were fine, and of a somewhat spiral form. There was no trace of fusion or of metallic deposit; and M. Ruhmkorff added that an energetic compression of the substance of the glass appeared to have accompanied the passage of the spark.

Origin of Electricity.—In a memoir translated in the *Bibliothèque de Genève* M. H. Buff considers the analogy of the sources of the electricity of friction and contact, and gives as the results of numerous experiments his opinion that the contact of heterogeneous substances is the cause of the former. This conclusion is combatted by the editor, M. A. De la Rive, who does not consider it to be fairly derived from the facts related. He considers that the experiments on the generation of electricity by pressure, from which M. Buff derives one of his principal arguments in favor of the contact theory, seem rather to prove that the origin of the electricity is much more related to the molecular movements, which arise as much from pressure as from rubbing, since, according to the nature of these movements, it is sometimes the positive, sometimes the negative fluid with which the two rubbed or pressed substances are charged.

ELECTRO-MOTIVE MACHINES.

Electro-motive machines depend on the power which soft iron possesses of acquiring, under the influence of the electric current, an enormous magnetic power, and of losing it instantly that the current ceases to circulate, whereby a rotary motion of immense rapidity is easily produced. Unfortunately, this attraction diminishes rapidly with the distance. To overcome this inconvenience, a distinguished engineer, M. Froment, has devoted much time, and believes that within certain limits these machines may be made useful. We learn from a memoir by M. De la Rive that a machine constructed of eighty

electro-magnets in six frames and ten movable wheels making the contacts has given a power of fifty-five kilogrammes per second. M. De la Rive, however, does not think that electro-motive machines can be ever profitably employed in industrial pursuits, but points out their advantage in regard to their avoiding the dangers of fire and explosion, as in the case of steam, and in requiring only a voltaic battery to put them in action.

MAGNETIC PHENOMENA.

M. Ruhmkorff has the following notice in the *Comptes-Rendus*, vol. l, p. 166:—"If a stay (*bride*) of soft iron be pressed against one of the poles of an artificial magnet, the soft iron is observed to become hard, and it is more difficult to file. If the stay be removed, it loses its hardness and resumes all the properties of soft iron."

NEW THEORY OF MAGNETIC CURRENTS.

Prof. Challis of Cambridge, England, has put forth the theory that magnetic currents are induced in the mass of the earth by its rotation. These currents, he says, are subject to modification by the earth's movement of translation, and also by the want of perfect symmetry in form. These deviations from symmetry determine the direction of the magnetic streams, which appear from experiment to enter the earth on the north side of the magnetic equator and to issue from it on the south side. The earth is thus a vast magnet, the streams of which are of constant intensity, excepting so far as they may be disturbed by cosmical influence. In this matter the sun and each of the planets act their part. That of Jupiter is likely to be predominant on account of his large size and rapid rotatory motion, and the Professor says it is not a little singular that the periodic time of Jupiter should coincide with the magnetic period discovered by General Sabine. This period has been shown in this country to be the same as that of the waxing and waning of the sun's spots; and it may very well be that the three are produced by the same cause.

MAGNETIC DISTURBANCES CAUSED BY THE MOON.

Prof. Airy, at the British Association, 1861, in discussing the magnetic deviations apparently caused by the moon, gave as his opinion, that they followed the law of the double tides, having the same epochs. There was a double tide of magnetism every lunar day, following the hours like the tides. There was, however, a considerable discordance in the results obtained for the several years of observation, though this did not destroy their value. No action of the moon as an independent magnet could produce this, and probably the influence was a reflected one from the magnetic earth. He also suggested that it was probable that the moon produced a double tide in the air, and if so in the oxygenic part of it, and they were therefore justified, from the recent discoveries of Mr. Faraday, in expecting a magnetic disturbance twice a day.

THE MOST ADVANTAGEOUS FORM OF MAGNETS.

To ascertain this has been the object of a series of experiments by Dr. Lamont, of Munich. Three determinations were required — the magnetic moment, the weight of the mass, and the moment of inertia. For this purpose Dr. Lamont procured hardened steel bars of various forms, magnetized them to saturation, and investigated every form by measurement for the above-mentioned determinations. The results are that narrow magnets are more advantageous than broad, thin than thick; and consequently the most advantageous form is that in which breadth and thickness disappear and the magnet is transformed into a mathematical line — *i. e.*, a so-called linear magnet — an imaginary one. Practically, there are two forms which appear advantageous — the flat, contracting to a point from the middle, and the flat prismatic. Details are given of six series of experiments, also tables of results, and engravings of the various form of magnets employed.

GALVANIC POLARIZATION OF BURIED METAL PLATES.

In consequence of the disturbances observed in the telegraphic wires during the appearance of the northern lights in 1859, Prof. Lamont was induced to contrive an apparatus at the observatory of Munich, in order to examine more closely into the occasional motion of the earth's electricity, and to determine its magnitude and direction. For this purpose large zinc plates were buried on the north, south, east and west sides of the observatory garden, the north plate being connected with the south and the east with the west by means of copper wires brought into the observatory and connected with galvanometers. As Prof. Lamont, in testing the apparatus, remarked certain phenomena which he attributed to galvanic polarization, it appeared to Dr. Carl advisable to subject the matter to more careful examination and to obtain more accurate measurements. Through the wire that connected two of the above-mentioned zinc plates a current, which he calls the terrestrial current, was perpetually circulating, the intensity of which was indicated by a fixed deviation of the galvanometer. Dr. Carl supposed that if a galvanic element were inserted in these conducting wires and again renewed, then, provided it caused no modification in the conductor, the needle of the galvanometer would return to its former position; but if, on the other hand, a state of galvanic polarization had been produced in the zinc plates, then the deviation of the needle of the galvanometer, after the removal of the element, would be greater or less than that exhibited by it originally, according as the direction of the galvanic current had been opposite to, or the same as that of the terrestrial current. On trial, the latter result exhibited itself so unmistakably that no further doubt could be entertained of the occurrence of galvanic polarization.

INTERESTING OBSERVATIONS ON ELECTRICAL PHENOMENA.

At a recent meeting of the American Academy, Prof. Wm. B. Rogers contributed the following observations relative to certain electrical phenomena.

The beautiful phenomena of *electrical light in rarefied gases*, as exhibited in the electrical egg and Gassiot's and Geissler's vacuum-tubes, afford many interesting subjects of inquiry. As the color of the light is dependent on the specific nature of the gas, and as this is reduced to an extreme degree of rarefaction, we have a means in some cases of identifying such substances when their quantity is so minute as to defy all other means of detection. With tubes of slender bore, affording, as has been seen, a light of great intensity, we may obtain a brilliant prismatic spectrum, which, as Plücker has shown, is marked in each case by some characteristic peculiarity; and with the same arrangement we are able to trace the chemical changes which the enclosed gas or vapor undergoes while subjected to the electrical action.

Perhaps the most important observations in this connection are those recently made by Gassiot, whose ingenious application of the absorbent power of potassa has enabled him to approximate more nearly to an absolute vacuum than any previous experimenter. In a tube thus prepared, he has found that the gas may be so excessively rarefied as to be unable to transmit the current, at this stage ceasing to be luminous. We may therefore conclude that the old notion of a vacuum being a good conductor, which was founded on the electric illumination of the Torricellian space, is entirely erroneous, and that in all cases conduction is dependent on the presence of some form of ponderable matter.

Adverting to the new evidences which these and other recent experiments afforded of the electrical character of the *Aurora*, Professor Rogers called attention to the action of a magnet on the electric light, and more particularly to its power of arranging the illumination in meridional bands, and impressing upon them a movement of rotation, as exhibited in De la Rive's experiment; and mentioned the ingenious suggestion of Grove, that the height of the aurora above the earth's surface might perhaps be inferred from a knowledge of the degree of rarefaction at which like luminous effects were obtained in the vacuum-tubes.

In connection with the *fluorescent* influence of the electric light, he mentioned the fact, that during the brilliant auroral displays of August and September, 1859, he found that a solution of sulphate of quinine showed its characteristic fluorescence quite distinctly when exposed during the height of the illumination.

Prof. Rogers stated that he had obtained a strong photographic picture on a collodion plate, from an electric flash, in less than half a second of time; and adopting the estimates of Wheatstone for the time an electric spark requires for transmission, a photographic impression had been obtained from an electric light less than $\frac{1}{10000}$ of a second in duration.

ELECTRO-CHEMICAL COLORATION.

In a memoir recently presented to the French Academy of Sciences by M. Becquerel, on electro-chemical coloration, the author stated, that Priestley was the first to obtain colored rings by means of electricity, by receiving strong charges from a battery, with surface of

about two square metres, on metal plates, by means of metallic points directed perpendicularly to their surface.

Nobili, in 1827, afterwards produced colored rings on platinum, gold, silver, and brass plates, by putting them in communication with one of the two poles of a voltaic pile, plunging them into metallic and non-metallic solutions, and then by directing perpendicularly to their surface a platinum point connected with the other pole. With positive silver, for instance, and solution of sea-salt, he obtained a series of concentric circles surrounded with varied irises, the tints being slightly dimmed by contact with the air. On heating the plates all the rings took a red tint.

M. Becquerel stated, that he began to study the electro-chemical coloration of metals in 1843; his chief object being, not to produce colored rings, but to deposit on plates of gold, platinum, copper and silver, thin and uniform layers of peroxide of lead, presenting successfully, according to the duration of the operation, which was generally very short, the rich colors of the spectrum. The operation consists in plunging into an alkaline solution of protoxide of lead the piece to be colored, put in connection with the positive pole of a voltaic pile charged with nitric acid and composed of many layers of plates, and closing the circle with a platinum wire in communication with the negative pole, and of which but the point, which alone touches the alkaline solution, is continually in motion. In contact with the object to be colored, the protoxide of lead, which forms the positive electrode, super-oxidizes, becomes insoluble in the alkali, and deposits itself on the surface in slight adherent layers, producing the color of the thin plates. Air and light gradually fade these colors — a disadvantage which may in great measure be avoided by covering the colored surface with alcohol varnish, which acts but very slightly on the peroxide. With a little practice all the tints desired may be given to a large object with hollows and projections, and each part painted with the appropriate color. M. Becquerel then described in detail a process discovered by himself by which these colors may be rendered permanent.

SINGULAR PROPERTIES OF WAY'S ELECTRIC LIGHT.

The following facts respecting Way's electric light (for description of which see *Annual Sci. Dis.*, 1861, page 108) are derived from the columns of the *London Photographic News*. The light which is obtained from the fluid mercury poles in Professor Way's arrangement is of a very peculiar character, unlike the ordinary electric light, which, as our readers are aware, is produced between two carbon poles, and contains at least as many different colored rays as sunlight itself. The mercurial light consists of only six definite homogeneous colors, each occupying a particular space in the solar spectrum, and having wide black intervals between them. The carbon electric light will thus illuminate any object with the exact color which it is best able to reflect; but with the mercury light it is Hobson's choice, — the object must either reflect one of the six colors evolved by the light, or it must remain in darkness. The colors are as follows: — First, at the lowest end of the spectrum comes a brick-red tint, next

to this is a strong yellowish orange, then two emerald green colors nearly touching; after these, and at some distance off, is a rich ultramarine blue, and lastly a violet. So far relates to color; but the rays evolved from the luminous mercury do not end here. Beyond the violet is another intensely energetic ray, but which, to be rendered apparent to the limited range of the eye, must be received upon some fluorescent screen, such as a piece of paper washed over with a solution of sulphate of quinine, or allowed to fall on a sensitive collodion plate. This latter surface makes known to us some other interesting properties of this light. Not only will this invisible ray impress itself strongly upon the plate, but the last two visible colors, viz., the rich ultramarine blue and the violet, are also seen to rival it in photographic action. Beyond these are other rays, equally energetic in their actinic power, and mounting higher and higher into the almost unknown regions of this invisible and mysterious part of the spectrum. The mercurial electric light thus appears to be almost unique in its properties, since, unlike other artificial lights, it is pre-eminently distinguished by the intensity and number of its photographic rays. Its peculiar properties will, however, obviously prevent its coming into general use at present. Thus, let any one imagine an assembly being illuminated with a light which is deficient in ninety-four per cent. of those colored rays which are usually met with in sunlight. Only those colors would be visible which were capable of reflecting the identical ray of the spectrum contained in the mercury light, and everything else, of whatever color it might be by daylight, would be totally black. Instead of having a thousand varied hues and tints to rest the eye upon, we should be limited to the six colors named above, and their combinations; and any one who has considered for a moment how intimately any system of internal illumination depends for its success upon the facility of reflecting and showing up varieties of colors and tints, will at once see that a source of light, however brilliant and valuable, could scarcely meet with private or public approbation if it were so signally deficient in discrimination as to transform the warm glow of health on a fair girl's cheek to the ghastly and cadaverous hue of death.

APPLICATION OF ELECTRICITY TO THE EXPLOSION OF GUNPOWDER.

The following is an abstract of a recent lecture on the above subject, delivered before the London Chemical Society, by Professor Abel, Director of the Chemical Establishment of the War Department (English):—

The lecturer commenced by giving a short historical account of the experiments instituted in this and foreign countries for the purpose of firing mines and cannon by electric agency, and referred to particular methods of operation adopted by Colonel Verdu, in Spain, and by M. Savare, in Paris, and to very extensive operations carried on by a system organized by M. du Moncel, at the port of Cherbourg-by MM. Dussaud and Rabattu, in 1854. The Austrian system of employing frictional electricity, and results of great magnitude obtained with it, were also briefly referred to.

A description was then given of the *galvanic fuse* which has been of late employed for firing guns during their proving trials. It consisted, essentially, of a quill tube, filled with compressed meal powder adapted to a wooden head, in which were arranged two small copper tubes, with a fine iron wire connecting them, and surrounded with gunpowder. When, therefore, a galvanic current of sufficient power was made to traverse the thin wire, it became heated to redness, and fired the loose powder and the composition in the quill tube, which, being inserted in the vent or touch-hole of the gun, insured the ignition of the whole charge.

Among the inconveniences arising from the application of electricity derived from the voltaic battery were, firstly, the necessity for employing *two* lengths of wire to complete the circuit, the tedious and difficult operation (in soldiers' hands) of charging the batteries with acid, and the inconvenience and risk of accident attending the transport of the necessary agents.

An extensive series of experiments had been instituted at Woolwich and Chatham, since 1855, by desire of the Secretary of State for War, by Professor Wheatstone and Mr. Abel, for the purpose of ascertaining the relative merits of different forms of electricity applied to the explosion of gunpowder.

The great improvements made in the construction of the induction coil apparatus by M. Ruhmkorff, rendered it desirable that experiments should be instituted, with small battery power, to obtain the effects of electricity of high tension; and the results were considered so satisfactory, that Mr. Abel pointed to this form of apparatus as possessing decided advantages for firing a great number of fuses simultaneously; in all cases, indeed, when the special nature of the operation would warrant the use of a battery.

A large magneto-electric apparatus, constructed by Henley, with a lever armature, was the first instrument tried at Woolwich for dispensing with the use of the voltaic battery. With this a great number of experiments were made in the endeavor to ignite gunpowder and other compositions of a highly inflammable nature. Little success attended these efforts until moistened gunpowder came eventually to be tried. This exploded, and led to the introduction of Mr. Abel's first "magnet-fuse." In describing its general construction, the lecturer called attention to the invaluable service rendered in these experiments by a particular form of insulated copper wires, manufactured according to his instructions, in which two thin wires were separately covered with a non-conducting coating, then laid side by side, and these twin wires further coated and bound up into one by an outer covering of gutta-percha. Whenever a cross-section is made in this the two copper wires are severed, and the terminals brought to view. Short lengths of this material were advantageously applied in the fuse-head, and placed so that the moistened powder rested on the bare terminals. Several hundreds of these quill-fuses were fired with the large lever-magnet with great certainty, the only failures arising from mechanical defects in their manufacture. As a convenient means of preparing the moist gunpowder in a state fit for priming the fuse, the ordinary fine-grained powder was saturated with a dilute alcoholic solution of chloride of calcium; on exposure

to the air for a day or two the spirit evaporated completely, and at the same time gave the deliquescent salt in the powder an opportunity of absorbing the necessary amount of moisture. The large magnet apparatus and a supply of suitable fuses composed a portion of an equipment fitted out during the late Chinese war for the purpose of clearing away the obstructions in the Peiho river.

Since that period an extended series of experiments has led to important improvements in the magnet-fuse. The priming composition is made more sensitive by the employment of a mixture of phosphide and sulphide of copper and chlorate of potash, instead of the moistened gunpowder, and is now so readily ignited that single fuses may be fired by the smallest magneto-electric machines, such as the American apparatus (a six-inch horse-shoe magnet and rotating armature), recently introduced for medical purposes.

Professor Wheatstone, who has been associated with Mr. Abel throughout the course of these experiments, has contrived a very ingenious and portable form of magneto-electric instrument, called by him the "magnet exploder." This will fire a number of fuses, either simultaneously or in succession, according to the arrangement of wires employed, on merely turning the handle of the instrument and pressing the stud or key, when the requisite velocity of the revolution of the magnet-armatures has been attained, and the preconcerted signal given. For the purpose of establishing metallic communication between the magnet-fuses and the "exploder," *one* insulated wire is all-sufficient; this need be but of small size, and, being led out from the machine, is inserted into one eye of the fuse-head; the other requires merely to be connected with the ground by a short length of ordinary copper wire attached to a small metallic plate buried in the earth close at hand. All that remains to be done in order to complete the earth-circuit is to connect the second binding screw of the "exploder" with the ground beneath, using a similar plate, or, more conveniently, a short wire passed under and dug in with a spade. In the event of a number of charges requiring to be fired simultaneously (frequently the case in engineering operations), the distant extremity of the main wire is placed in communication with a corresponding number of short branches of insulated wire, each leading to a mine; the juncture of the main wire with the branches is effected by twisting the bare ends together with pliers, binding the joint round with fine copper wire to insure proper connection throughout, and then simply covering it with sheet caoutchouc or water-proof canvas, to maintain perfect insulation. The ground wires of the series of mines are, for greater certainty, collected into one, and secured as a single earth connection. With ordinary attention bestowed upon the repair of any injuries which the insulated wire may accidentally sustain in the course of rough usage, no difficulty is experienced in directing the operations at a great distance from the scene of the explosion. The use of ordinary uncovered wire, supported above the ground on poles or stakes, provided with insulators, was referred to as another means of conveying the magnetic current to a distance.

The modifications rendered necessary in the general arrangements for the carrying out of submarine explosions were briefly described. The obstacles in the way of success were represented to be greater

in this class of operations, especially when more than one charge has to be fired, on account, firstly, of the increased difficulty in thoroughly insulating the conducting wire and the necessary connection; and, secondly, because of the flowing in of the water upon the bared poles immediately after one or two in the series were ignited, thus, by completing the circuit, preventing the explosion of the rest. The charge of powder was enclosed either in a tin canister or a Mackintosh bag, with a fuse in the midst, and connection established with the insulated wire on the one hand, whilst the other pole was placed in communication with the metal of the canister, or brought out into the water in the case of the vulcanized India-rubber bag.

THE AURORA OF SEPT. 2, 1859.

Professor Loomis thus locates the geographical position of the celebrated aurora of Sept. 2d, 1859:—

It formed a belt of light encircling the northern hemisphere, extending southward in North America to lat. 22½°, and reaching to an unknown distance on the north; and it pervaded the entire interval between the elevations of fifty and five hundred miles above the earth's surface. This illumination consisted chiefly of luminous beams or columns, everywhere parallel to the direction of a magnetic needle when freely suspended; that is, in the United States these beams were nearly vertical, their upper extremities being inclined southward at angles varying from 15° to 30°. These beams were, therefore, five hundred miles in length, and their diameters varied from five to ten and twenty miles, and perhaps sometimes they were still greater.

These beams were simply illumined spaces, and the illumination was produced by a flow of electricity. That this illumination was produced by electricity is proved by the observations of the magnetic telegraph. During these auroral displays, there were developed on the telegraph wires electric currents of sufficient power to serve as a substitute for the ordinary voltaic battery. That the agent thus excited upon the telegraph wires was indeed electricity, is abundantly proved.

Professor Loomis also states that it appears from the result of his observations that the remarkable auroral display which prevailed throughout a large portion of the northern hemisphere from Aug. 28th to Sept. 4th, 1859, was accompanied by a display about equally remarkable in the southern hemisphere; and the periods of greatest brilliancy were nearly contemporaneous in both hemispheres. It also appears, from examining the records of the British Magnetic Observatory at Hobarton, in Van Dieman's Land, running through a series of years, that every time that an aurora has been seen in the horizon of Hobarton an aurora has appeared the same day in the northern hemisphere, or at least such extraordinary perturbations were observed as are almost certain indications of the presence of an aurora in positions more or less distant. If the number of these coincidences were not as yet too few, we should naturally be led to admit that an extraordinary aurora in the southern hemisphere is always accompanied by one in the northern; in the same way as all the causes

which affect the magnetism of one pole of a magnet equally affect that of the other pole.

SACRIFICIAL METALS.

It is a fact perfectly well known to chemists, but one which mechanicians have not heeded nearly so much as it deserves, that when two metals are retained in contact, and conjointly exposed to chemical influences during long periods of time, one metal sacrifices itself to ensure the other's preservation. The history of ships' copper sheathing shall be taken as our first illustration of the sacrificial metallic function. Sir Humphrey Davy, as is well known, devised a method of checking or altogether obviating the destruction of ships' copper sheathing. He accomplished this by attaching to the ship's bottom, at suitable intervals, slabs of the metal zinc, and which he called protectors. Protectors they were, in the following manner: The zinc rapidly corroded, and was lost; but, so long as any zinc remained for the sea-water to act upon, the copper remained untouched. So far as copper preservation is concerned, the method adopted must be pronounced efficient. Practically, it failed, indeed, to secure the advantages described, but not for any reason that concerns us here. It was found that when copper no longer slowly dissolved, it ceased to be a poisonous metal. Barnacles and seaweed attached themselves, just as they might have done to an uncovered wooden bottom; and, moreover, owing to a galvanic action set up, the ship's copper was rapidly fouled by a deposition of magnesia and lime, precipitated from the magnesian and calcareous soluble salts always present in sea-water. Failing, then, to achieve what was intended by it, the copper-protecting process of Davy ceased to be employed; but the failure of it is that which alone concerns us here, as illustrating what we would wish to convey by the words "sacrificial metal."

Take, as the next example, the illustration afforded by the setting of an iron paling-rail in a bed of lead. The most casual observation as one passes along the streets of a city may be made more pregnant with facts bearing upon this matter than the longest homily. For a time, varying as to length with locality, external influences, and perhaps, in some degree, on the varying quality of the iron and lead brought into contact, both metals remain sound. But after a time decay inevitably sets in, and, when once commenced, marches to the issue of final destruction with wonderful rapidity. The remarkable fact is that both metals do not decay simultaneously; it is the iron which corrodes, whilst lead — the softer metal — remains intact. Let the mechanician do what he will, this result cannot be prevented; a law of nature having decreed the sacrifice, it must and will be achieved.

Our next illustration shall be ordinary tin plate — iron coated with tin, as is well known. Well, what sort of destruction is set up when tin plate has been exposed for a long duration of time to the atmosphere? Is the tin destroyed? does it tarnish, even? Never. Iron is the sacrificial metal here; and as surely as the iron is anywhere exposed, it perishes, crumbles, and dissolves away, with destructive rapidity. The rate of destruction of iron totally unprotected

is slow by comparison with that which ensues when, owing to a flaw or disintegration of the covering tin envelope, atmospheric agencies come into play upon the underlying metal.

But the case we most particularly wish to direct attention to, is the result of bringing zinc into contact with iron, and retaining the two metals together over long periods, as may be seen in the so-called galvanized iron. Under this latter disposition zinc becomes the sacrificial metal. Not one particle of iron decays so long as atmospheric destructive agents can wreak their dissolution — so to speak — on the protective zinc. Nor does this protection altogether depend on a complete covering of the iron. Flaws and imperfections there are, and necessarily must be, through which, quite down to the iron, destructive agents, always present in the atmosphere, must penetrate. They do not act upon the iron, nevertheless, so long as a sufficient expanse of protective zinc surface remains; and this simply because a fundamental law of nature forbids their doing so. — *London Mechanics' Magazine.*

NEW APPLICATION OF ELECTRICITY.

Mr. Siemans, the well-known English electrician and physicist, in a late communication to the *Philosophical Magazine*, thus describes a striking and most fortunate application of a known fact in electricity. We usually figure this agent as a fluid, and somewhat grossly imagine it to pass through conductors as water does through pipes. The symbol does no harm so long as we know that it is a symbol; and the friction of a liquid in passing through a narrow pipe, answers, perhaps, sufficiently well to illustrate the resistance encountered by an electric current in passing through a wire. The longer the wire is, the greater is the resistance; and wires of the same thickness and length, but of different chemical constitution, offer different amounts of resistance to the passage of an electric current. A wire of platinum, for example, one yard in length, will throw the same obstacle in the way of a current as a wire of silver twelve yards in length and of the same thickness. But besides difference of dimension or difference of chemical quality, there is another circumstance which influences the conductive power of a wire, and that is its temperature. As a general rule, when the temperature of a wire augments, its resistance to the passage of an electric current augments, or, in other words, its conductivity becomes diminished. We can express the resistance of any wire in numbers referred to a fixed standard. We can also determine with the utmost exactness the augmentation of electric resistance due to any given augmentation of temperature. Conversely, we can accurately infer the increase of temperature from the increase of resistance; and this is the principle which Mr. Siemans has so happily applied. He had charge of the Rangoon and Singapore telegraph cable, and was led by previous observation to surmise that a spontaneous generation of heat sometimes took place when large lengths of such cables are formed into coils. He was, therefore, anxious to keep himself acquainted with the temperature of the interior portions of his coil, but could not, of course, introduce ordinary thermometers there. He introduced, however, between the layers

of the cable, at regular intervals, suitable coils of copper wire, the resistance of which, for a long series of temperatures, had been determined beforehand. The ends of these copper coils issued into the air, so that they could be connected at any time with a suitable apparatus for determining their resistance. Now, Mr. Siemans found that although the outer portion of the coil of cable had a temperature not sensibly higher than that of air, the wires which he had placed within the coil showed a steady augmentation of resistance, from which he inferred that the cable was heating within. He waited until the augmented resistance indicated an increase of temperature from sixty to eighty-six degrees. Had he waited much longer, the cable would probably have been destroyed. Some of those to whom he communicated his conclusions regarded them for a time as the mere refinements of theory; but all their doubts were dissipated when a quantity of water, at a temperature of forty-two degrees, thrown upon the top of the cable, after passing through the inner portions of the coil, issued from its bottom raised to seventy-two degrees! The precise cause of this generation of heat has not, we believe, been yet determined. It may be due to some chemical action in the gutta-percha; but it may also be due to the gradual rusting of the iron which encases the cable. The rusting of iron is really the burning of iron; but this burning, under ordinary circumstances, is so slow that the heat generated is all dissipated in the air. But if this dissipation be prevented, it is easy to see that such an accumulation may take place as would produce the effects observed by Mr. Siemans, and still worse effects, if not guarded against in time. Were the human skin, for example, an envelope impervious to heat, which prevented the escape of the warmth generated by respiration, each of us would very soon act the part of a Pepin's digester upon his own bones, and boil them into jelly. Who can say what injury was done to the gutta-percha covering of the Atlantic cable through ignorance of the fact, observed so opportunely in the case of that of Rangoon and Singapore?

SUBMARINE TELEGRAPHS.

From a report on the condition of submarine telegraphs, recently issued by the London Board of Trade, we derive the following information: —

Up to the present time, 11,364 miles of submarine telegraphic cable have been laid; but only about 3,000 are actually working. The lines not working include the Atlantic, 2,200 miles; the Red Sea and India, 3,499 miles; the Sardinia, Malta and Corfu, 700 miles; and the Singapore and Batavia, 550 miles. The committee give a succinct history of these, as well as of all the others, and state their conclusions. The failure of the Atlantic is attributed to "the cable having been faulty, owing to the absence of experimental data, to the manufacture having been conducted without proper supervision, and to the cable not having been handled after manufacture with sufficient care;" and they add that "practical men ought to have known that the cable was defective, and to have been aware of the locality of the defects before it was laid." The Red Sea and India

failure is considered to be attributable to the cable having been designed "without regard to the conditions of the climate, or the character of the bottom of the sea over which it had to be laid, and to the insufficiency of the agreement with the contractor for securing effectual supervision during manufacture and control of the manner of laying."

Looking at these circumstances, and similar ones in connection with other lines, the committee point out that the failures in every case are assignable to defined causes which might have been guarded against.

In regard to the best material for conductors, the committee state, that after much experimentation, no substance has been found which added to *pure* copper will increase its conducting power.

As regards the material for covering telegraph cables, it appears that India-rubber was almost the first substance that had been used for covering overland wires; and the report says "it is remarkable that the first really efficient insulating substance that was used, after falling into disuse, should be now again brought forward. As in the copper for the conductor, so India-rubber appeared almost specially intended for the purpose of insulation. It possesses insulating qualities of the highest order. It is tough, highly elastic, of less specific gravity than water, easily manipulated, extremely durable under water, nearly impervious to moisture, and it appeared on its first introduction as though nothing further could be desired."

The reason set forth for its disuse is stated to have been defective application. After the first failure of India-rubber, gutta-percha was introduced to take its place; and up to the present time it has been used as the chief insulating agent.

The report states that the committee made numerous experiments with both India-rubber and gutta-percha as a coating for submarine cables. It was found that pressure consolidated the material and improved the insulating qualities of both gutta-percha and India-rubber. Temperature was found to produce a marked effect upon these substances in relation to the insulating powers. Thus, with the gutta-percha, the insulation was not half as good at a temperature of seventy-five degrees Fah. as at fifty-two degrees, and not one-fourth as good at ninety-two degrees. At a temperature of thirty-two degrees its insulating qualities were three times as good as at fifty-two degrees. At a temperature of one hundred and thirty-two degrees, gutta-percha-covered wire was entirely spoiled. Temperature does not affect India-rubber so much as gutta-percha.

Both these substances, however, were found to be porous under great pressure in water, and this seems to be the great difficulty to overcome so as to make them more perfect insulators.

In conclusion, the committee repeat their belief that the exercise of due care might have prevented all the unsatisfactory results that have thus far attended this branch of enterprise, and that if proper regard be henceforth bestowed upon the question the results will prove as successful as they have hitherto been disastrous. The evidence appended is extremely voluminous, and occupies five hundred and twenty pages.

PRIVATE TELEGRAPHS.

The establishment of private telegraph wires in Great Britain is becoming quite frequent, and a company, even, called the "Private Telegraph Company" has been instituted in London.

Instead of having wires as in ordinary cases, they suspend from posts a rope containing a multitude of wires — perhaps thirty, or, if that is not enough, forty or fifty, or more. One feature of such a plan is, that all parties can have a telegraphic communication at a very reasonable rate. The expense of erecting telegraphs according to the ordinary system is about sixty-five pounds per mile; but by the plan proposed by the new company, of multitudinous wires, parties were enabled to rent a wire at a sum of four pounds per mile per annum. Therefore, merchants residing one, two, or three miles from their places of business, or having places of business so far apart, can have private communication at either four, eight or twelve pounds per annum. Another great feature connected with the establishment of this company is this, — the apparatus is so simple, that parties require no instruction in the use of it. To send a message it is only necessary to press the key opposite any of the letters of the ordinary English alphabet, which are marked on an index, and by turning a little handle the message is immediately transmitted to a corresponding instrument at the other end. Another thing connected with the instrument is the total absence of battery power, the current being produced by turning a piece of soft iron near a magnet. The power being so generated, and the magnet not being liable to deteriorate, the instrument is at all times in perfect order. People might leave their houses for six months, and when they went back they would find it in order.

In Manchester, Mr. W. Fairbairn, the eminent engineer, had consented to carry out the principles of the company, and Professor Wheatstone had undertaken the management in London, where it was intended to have wires erected between the Houses of Parliament, the Exchange, and all the principal newspaper offices.

THE ATLANTIC AND PACIFIC OVERLAND TELEGRAPH.

One of the most important events in the scientific or commercial history of the past year (1861), has been the completion and successful operation of a line of telegraphs across the North American continent, between the Atlantic and Pacific States. The inception of this enterprise dates from 1859, when the project was brought before a convention of representatives of the various telegraphic companies of the United States, and application to Congress for assistance in completing the work agreed on. Such application was duly made, and in June, 1860, Congress passed a bill authorizing and directing the Secretary of the Treasury to advertise for proposals to carry a line of telegraph to California, across the continent, within two years from July 31st, 1860, securing certain privileges to the government and to the proprietors of the line.

Mr. Cobb, who was then Secretary of the Treasury, did not favor the project; and the telegraph companies seem to have been averse to entering the field or risking money on the enterprise. In August,

1860, after the law had passed, a meeting of the directors of the various telegraph companies in the country was held in New York; and, after some deliberation, a resolution to unite and co-operate for the construction of a Pacific telegraph was rejected, and another passed instead, declaring it inexpedient to embark in the enterprise, but consenting that any of the parties who chose might do so.

When the notice for proposals was advertised by Secretary Cobb, Mr. Hiram Sibley, President of the Western Union Telegraph Co., who was really the proposer and author of the whole enterprise, put the question to the directors of his company whether they would authorize proposals to be sent in; and so formidable and unpropitious did the undertaking appear that it was favorably carried only by a single vote.

After long and tedious delays on the part of Secretary Cobb, the contract to build the line was awarded, on the 20th of September, 1860, to Mr. Sibley, the President and representative of the Western Union Company. Here we may add that this company at once assumed the contract, and furnished all the money expended on the line east of Salt Lake.

They at once dispatched one of their number, Mr. J. H. Wade, of Cleveland, to California, to confer with parties on that side and persons who had travelled the various routes, and determine where and how to build the line, as also to make such arrangements with the companies on the Pacific, or such of them as might agree, either for a business connection at the then terminus of their lines, or to induce them to extend this way. After various discussions, the route was at last settled on; the California companies covenanted to assume the construction of the line to Salt Lake with all dispatch, and if possible as soon as the eastern section should be completed to that point — an undertaking which they honorably performed, reaching Salt Lake but a few days later than the Western Union party.

It was not an easy matter to determine the route, and there were even different opinions as to the kind of line to be built. Some favored underground wires, some the usual pole line. The troublous aspect of affairs South induced the company at last to determine on a line to run by way of Fort Kearney, Fort Laramie, Fort Bridger, crossing the Rocky Mountains at the South Pass, thence to Salt Lake City, thence, via Fort Crittenden, by the Simpson route to Fort Churchill, Carson Valley, thence over the Sierra Nevada Mountains to Placerville and San Francisco — being substantially the same route as that over which the present overland mail is carried.

Mr. Edward Creighton was appointed superintendent of construction in the eastern part of the line, and the California State Telegraph Company got ready to commence operations on their end. From the known imperfection of underground lines, so far as they have been tried in Europe, it was decided to put the lines to the Pacific on posts, notwithstanding the deep snow on the mountains in the winter, the scarcity and expense of getting timber, its liability to be burnt with the grass on the plains, run down by buffaloes, or be stolen for timber and fuel.

Mr. Creighton had already surveyed the proposed route, and was convinced the poles could be maintained. The manner of his survey

is curious, and shows how much genuine enterprise was brought to bear on the construction. He started on the overland route alone, in November, 1860; travelled most of the way on mule-back, with such company as he could pick up on the road — journeying much of the way entirely alone. His object was to examine the route thoroughly, and, if possible, to see the Indians, and learn from them more of the country and its features and resources than could be gathered from a more rapid journey. He started at a time when the Indians are most dangerous to travellers, because they are suffering for food; but instead of avoiding them, he took pains to go out of his way to meet them. He got from them much valuable information as to the different routes, depth of snow on each, the kinds and quality of timber, and where to find it, etc. He came to the conclusion that, with the exception of a few lawless, thieving Indians that disgrace every tribe, they are quite as harmless, when properly treated, as many of the whites that go among them. He afterwards employed some of them to accompany the train while building the line, to herd and look after the stock, for which the most trusty of them are the best help for the purpose he could get.

Mr. Creighton reached San Francisco on March 1st, and immediately returned to New York by steamer with Mr. Wade. The outbreak of the Southern insurrection made the speedy construction of the line of greater importance, and no time was to be lost in getting together the material. Accordingly the directors met at Rochester, and organized the company, April 17th, by electing J. H. Wade, president; H. Sibley, vice-president; and E. Creighton, superintendent; after which nearly all the material had to be made.

The wire to be used on the line was No. 9 galvanized iron wire. The insulators, wire, and tools were taken to Omaha, Kansas, at which place all the material of the expedition was gathered to start westward.

With a remembrance of the manner of constructing telegraph lines in his mind, the reader will be able to judge of the labor required to set up two thousand miles of telegraph, through a wilderness inhabited only by Indians and wild beasts, and parts of which are a dreary desert. Of the force employed on the Pacific side we have no knowledge; but Mr. Creighton, for the line from Omaha to Salt Lake, had four hundred men, fitted out with tents, tools and outfit for a hard season's campaign, including rifles and navy revolvers for each man, with the necessary provisions, including one hundred head of fat cattle for beef. These were driven with the train, and killed as they were needed.

For transportation of material for the line and provisions for the little army of workers, five hundred head of oxen and mules, with over one hundred wagons, were purchased by the company, and this not proving sufficient, other transportation was hired, making the total number of beasts of burden up to seven hundred oxen and one hundred pair of mules. When all was ready, the party started from Omaha, and set their first pole on the 4th of July. The line was completed to Salt Lake on the 18th of October, and the California party reached Salt Lake six days later, on the 24th.

They advanced at the rate of about ten miles per day. The whole

line is on poles, it being thought best to cross rivers in this manner rather than lay submarine cables. The wire used weighs three hundred and fifty pounds to the mile, which would make, for the line, from Brownsville, Mo., to San Francisco, seven hundred thousand pounds of wire. The posts are good size, thirty to the mile, and more than half of them red cedar, the balance mostly of pine.

The country is destitute of timber most of the way; but the longest distance that posts had to be hauled in any one stretch was two hundred and forty miles. As before stated, no submarine cables were used at river crossings; but the wire was carried over sometimes on high masts, where common poles did not give sufficient height. On the high mountains, where the snow accumulates to such fabulous depths, the posts are extra large, and so high as to keep the wire above the deepest snow, and so near together that the wire will not break by the snow and sleet that will load upon it.

Extra mule teams were kept along with the train for carrying the men to and from the works, for hauling water for the men and animals on the deserts, and other necessary running about, and the line was completed as the train moved westward.

The line is worked by Morse's instruments. The cost of the line will average about $250 per mile, the whole cost not exceeding $500,000. Towards this the United States government pays $400,000 in ten yearly instalments, and the State of California pays $60,000.

The section on the California side was built by Mr. Street, of California, and at about the same rate of progress, ten miles per day, as this side.

The charge on the Pacific telegraph for a message of ten words, from Brownsville, Missouri, to San Francisco, is three dollars. The charge for ten words from New York to San Francisco being now about six dollars ($5,95), with the addition of forty-eight cents for every additional word, the public are already availing themselves of the line to a considerable extent. The average number of messages per day sent over so far is about sixty, exclusive of news reports and government dispatches, the latter amounting to an average of four messages a day.

The danger to the line from Indian hostility does not seem so great as has been feared. The Indians have been conciliated, and some were employed to aid the regular force of workmen. One tribe has now the care of the stock which was used for transportation.

The whole continuous stretch of telegraph wire across this continent, between Cape Race on the east and San Francisco on the west, is about five thousand miles.

Its extremities comprise seventy degrees of longitude, making a difference in time of more than four and a half hours. The agents at Cape Race might send a dispatch forward at set of sun, and the news reach San Francisco while that luminary was still above the horizon. If a telegram were instantaneously sent over the whole line, it would reach San Francisco at a time, according to the clocks of that city, about three hours and fifteen minutes before the time at which it left New York, according to the clocks there.

There is now in operation in California about two thousand miles of line, extending south from San Franciso to Los Angelos, and north

about the same distance to Yreka, connecting every town of importance in the State. The line will probably be extended within a year as far north as Vancouver, and from there Mr. Collins proposes to carry it along the north-western coast of America, and over to the eastern shore of Asia.

In this proposed extension, the Russian government has expressed a great interest, and is ready to offer assistance and facilities. It has, moreover, already made considerable strides in the establishment of a system of telegraphy across the Asiatic continent, a line of telegraphs being in the process of construction across the Ural Mountains to Omsk, which, connecting Europe with Asia, will be extended in 1863 to Irkutsk, and will connect the Russian ports through the Sea of Japan and the Amoor. In the following year, it is expected that an uninterrupted telegraphic communication will exist between St. Petersburg and the Pacific. So far, assuming that the projects of the Russian government will be realized, no difficulties seem to lie in the way of sending telegraphic messages with requisite dispatch from Europe to the shores of the Pacific Ocean. The Pacific Ocean as it passes northward gradually narrows itself till it terminates in the channel which separates the Asiatic and American continents. This channel, known by the name of Behring Straits, is at its narrowest point about fifty miles broad. Regarding solely from a submarine point of view the proposed line of telegraphic communication, this would seem the most favorable point at which to connect the continents. The adjacent countries, however, clad in perpetual ice, are uninhabitable, and the establishment of telegraph stations, or aërial lines (wires supported on poles), across them would be impracticable. It is out of the question, therefore, to go so far north. At a point further south, however, though the distance between the opposite coast is as great as that between Ireland and Newfoundland, opportunities are presented eminently favorable for the establishment of telegraphic communication. A range of islands, called the Aleutian Islands, are scattered over the intervening space. A telegraphic cable, it is contended, might with ease be laid down between those islands and the main land on either side. Two modes present themselves of accomplishing this object. The one by making each island, as it is in turn traversed, available for the establishment of aërial lines, and adopting the submarine system only where absolutely necessary, namely, in connecting the several islands with each other, and the group with the main land. The other consists in adopting the submarine system throughout, and carrying the cable along the coasts of the islands, instead of across them. The former plan is condemned as impracticable, and the latter proposed as the safest, though most expensive mode of proceeding.

From this rapid glance, therefore, it will be seen that the idea of telegraphic communication with the Old World is in a fair way to be realized in the course of a few years.

RELATION BETWEEN OUR PERCEPTION OF DISTANCE AND COLOR.

The fact that a landscape appears more vivid in color, when viewed by the eyes brought into an abnormal position, as in looking under the arm, etc., is well known. Some persons have attempted to explain this fact by the influence of an augmented pressure of the blood upon the retina. In an easy reclining posture, where such pressure can hardly exist, I observe this heightening of tints with great distinctness, also by viewing the inverted image of the landscape by total reflexion through a rectangular prism, the head being in its natural position. Dr. A. Müller with more probability has referred this appearance to the different accommodation of the eye for horizontal and vertical lines. To me it seems that this effect is intimately connected with our perception or non-perception of distance. In gazing at landscapes, the ordinary habit of most persons, artists excepted, leads them to pay attention to the forms and *distances* (which alone have a practical value as objects of observation), and to neglect the *color*, particularly those portions of it which are subdued. When now by any means the mind is prevented from dwelling on distance, it is thrown back on the remaining element, color; and the landscape appears like a mass of beautiful patches of color heaped upon each other, and situated more or less in a vertical plane.

1. A perpendicular position of the eyes reduces very considerably our perception of depth or distance, so that false estimates of it are formed by the eyes in this new situation. With the exception of objects in the foreground, all things seem to lie not far removed from the same vertical plane.

The reason is partly to be found in the fact, that while in normal vision our binocular perception of depth is obtained by regarding vertical lines, trees, etc., in vertical vision the same objects, though instinctively sought, afford us no information.

2. In normal vision with a single eye, there is certainly, in a binocular sense, no perception of depth, nevertheless the mind occupies itself with the idea of distance, and if the objects are familiar there is no augmentation of color perceived. By inverting the image of the landscape with a rectangular prism the objects fall into almost one plane, are diminished in apparent magnitude, and the mind, unable to trace distances through this maze, is forced to dwell on the mass of tints presented.

3. With the erecting or inverting telescope, in proportion as the objects viewed are divested of the idea of solidity or depth, can their more delicate tints be perceived. Objects, which in normal vision seem to us nearly without color, are best fitted for these observations; a bare pile of stones and dry mud viewed through a telescope appears often like a richly tinted water-color drawing.

It would seem probable that if we could add to paintings of landscapes the element of distance, the mind, occupied with this, would no longer dwell on the richness of the tints. In confirmation, I find that colored stereographs of landscapes, which out of the stereoscope seem exaggerated in tint, when placed in the instrument no longer appear too highly colored.

From the foregoing considerations, then, it would appear that when the mind is engaged with the perception of distance, the *presence* of color is often overlooked; its *absence* may remain unnoticed from the same cause; for in uncolored stereographs of objects that are perfectly familiar to the observer, it will sometimes be noticed, that those articles which do not greatly differ in color from the tint of the photographic paper, are seen in the stereoscope with an approximation to their natural hues; upon withdrawing the slide from the instrument no trace of such tint is perceived. Objects that are free from lustre, as well-worn carpets, answer for this purpose. That this should be the case with the tinted photographic representations of white objects can be explained of course in another way. — *Contributed to Silliman's Journal, Sept.,* 1861, *by Prof. O. N. Rood, Troy University.*

The chromatic effects here noticed by Prof. Rood are well seen in the ordinary camera and dark chamber. Thus the human countenance, when not florid, presents to the unartistic eye few or no traces of pink or flesh color — but every one who has seen it in the camera, must have observed with what distinctness the image is colored. The same is true of familiar landscapes, when seen inverted upon the screen in a dark chamber. Here the neutral tints, which in nature are almost unnoticed by the common observer, stand out as distinct patches of color in the way so well described by Prof. Rood. — *Eds. Journal.*

NIGHT TELEGRAPHIC SIGNALS.

A plan for communicating between lighthouses, forts, ships of war, etc. at night, has recently been invented by Mr. H. P. Tuttle, of the Harvard Observatory, Cambridge. It consists of a box about six inches wide and twelve long, with an aperture in front through which is seen a brilliant light. The aperture is provided with a cut-off which is worked by a lever, and the system by which the characters are made is precisely the same as those of our Morse telegraph: different combinations of length, there being only two lengths, with the number of times the light is cut off, designating each letter of the alphabet, which are read by sight; whereas, the same characters over a telegraph wire are read in our telegraph offices by sound. The distance at which the light can be read depends upon the quality and size of the lens, which is immediately behind the aperture. Those already experimented with are common dark lanterns, and are brilliant enough to be read distinctly at a distance of three miles. Lamps can be made at a very slight cost which can be read ten miles with the naked eye, and by aid of glasses, twenty-five miles.

Powerful lights can also be used, which may be read twenty-five miles or more with the naked eye. Two telegraph operators, in connection with Mr. Tuttle, experimented at night between the cupola of the State House, Boston, and the top of the Bunker Hill monument, carrying on a spirited conversation without the slightest trouble. From ten to fifteen words per minute were transmitted with rough and imperfect machines. The rapidity of transmission can be considerably increased by using machines of improved manufacture.

It is not necessary for telegraph operators, exclusively, to operate

these machines, although they can operate much faster than others. Any man of ordinary intelligence and quickness of comprehension, by committing the alphabet to memory, could read and write slowly, and increase in rapidity as fast as "practice makes perfect."

It has been remarked that, for war service, many others than the correspondents would understand the lights; but this obstacle to its introduction is very easily removed by transmitting dispatches in cipher, which is an easier method of sending the same amount of matter, and, at the same time, unintelligible to all excepting the correspondents themselves.

NEW EYE-SHADE—THE OCCHIOMBRA.

Mr. Joseph Calkins, of London, has patented a transparent eye-shade (*Occhiombra*), which promises to be a boon to those who suffer from impaired vision, or temporarily from inflammation, or other irritating causes.

Its general appearance is that of the usual shade, but more symmetrical in its outline. It consists of a very light wire framework, fitting with a spring closely round the forehead, just above the eyebrows; and over the framework is extended an extremely fine transparent fabric of gauze or other material. A portion of the wire framework, almost invisible to the by-stander, rests upon the nose, passes close to the face under the eyes to the temples, supporting the fabric from the lower part of the shade, thus forming one large closed chamber for the eyes.

The fineness of the fabric will be found to protect the wearer from wind, dust, and sun, but allows of sufficient ventilation to keep the eyes perfectly cool; and a lengthened opening at the top of the shade, not observable when worn, provides for the escape of any heat that may be engendered by violent exercise — the want of which is felt in the ordinary shade.

The occhiombra can be placed and removed with the same ease as a pair of spectacles, and is so light as to be scarcely perceptible to the wearer, being in weight about half an ounce. The fabric is sometimes doubled, to meet the requirements of those with weak or inflamed eyes, but is sufficiently transparent, in all cases, to enable the wearer to thread his way through any crowd with perfect comfort.

The occhiombra will be found of great service in protecting from wind and ashes those who travel by railroad. Travellers in India and Egypt, and Alpine excursionists, will find it of inestimable benefit — the first as a protection from sun and sand, and the latter from sleet, wind, and the painful glare from the snow. It also relieves the angler from wind and glare on the surface of the water; but it will be found of *especial* service to ladies, and those who visit the sea-side, protecting them from excessive wind and light, rendering it unnecessary for the former to wear a veil, and thus allowing free respiration of the pure sea air.

The occhiombra does not in any way interfere with the wearing of spectacles, and is manufactured in different colors, to meet the tastes of those who adopt it.

THE CLOUD-MIRROR AND SUNSHINE-RECORDER.

At the meeting of the British Association, 1861, Mr. J. T. Goddard called attention to the two above-named contrivances. The cloud-mirror was simply a mirror of a circular form with the points of the compass marked on its frame; this, being presented face upwards to the sky, enabled a person to draw with considerable accuracy, at any desirable moment, the configuration of the clouds relatively to the horizon and to each other. The sunshine-recorder was a piece of photographic paper placed in the bottom of a box blackened inside, the top of which had in the centre a small circular hole, through which a slender beam of sunlight could be admitted to pass on to the photographic paper. When the sun did not shine no mark was left on the paper; when it did, its varying diurnal course left a corresponding line on the paper, its position marking the hours of sunshine, and its breadth and depth of shade indicating the greater or less radiating power of the sun.

The President observed that he had once been shown a very simple sunshine-recorder. It consisted merely of a hollow hemispherical wooden disk, concentric with which was placed a glass spheric lens, whose focal length was made exactly equal to the radius of the wooden disk. As the sun moved along in its diurnal course, the concentrated light and heat burned a corresponding line on the bottom of the disk, more or less intense the brighter or less brightly it radiated, and altogether deficient when it was obscured by clouds.

THE TROCHEIDOSCOPE.

This name has been given to a recent invention designed for displaying various effects of the combination of colors upon a novel principle — some of them in a most brilliant manner. It consists mainly of a train of wheelwork, so arranged that by gently turning the handle the horizontal disk-table is made to revolve at varying speed, at the will of the operator, from fifty to two thousand revolutions per minute. In the centre of the disk-table is a carefully-fitted spindle, with a screw and flange at the lower end, and a shoulder at the upper end, just under which is a universal joint for adjusting the position of the topmost portion, upon which the patterns or devices are to be hung when exhibited. Proceeding from the side of the instrument is an arm of brass, with a small appendage or hook at the top for receiving the strings of the patterns, and a spring to act as a check upon the disks used in the protean experiments. The spindle is jointed near the top to give a peculiar vibratory motion to the pattern when fitted. As the spindle revolves it strikes the sides of the circular hole by which the pattern is suspended, and so imparts to it a shaking motion just sufficient to fill up the pattern with all the colors on the disk below, but then lost to the eye by its rapid revolutions. If the pattern were perfectly still, the colors would not appear; but if allowed slight motion, as above described, the colors are reproduced upon the principle — that of images being retained upon the eye — which is thus elucidated in a very beautiful manner. — Described and figured in the *London Mechanics' Magazine.*

THE GONIOMETROSCOPE.

MM. A. Huray and H. Leile, of Paris, have patented an instrument denominated a goniometroscope, by the aid of which patterns of flowers, lace, and other small objects, can be multiplied and reflected at any given angle, from a triangle upward. The instrument consists of wood, opening like a book. The two sides forming the case are hinged at the back, so that when required they will stand on end, the back being in a vertical position. The sides are each covered on the inside with a thin sheet of copper plated with silver, and burnished. These serve as reflectors, and the reflection is intended to be made in the very centre of the pattern. A protractor — a half-circle marked off in degrees — is secured at the top of one side of the case, at a short distance from the hinged back. By this the different angles can be readily found, the protractor being held firmly by a small holder, having a regulating screw on the other side of the case. Through each side of the case, near the opening part, there passes a vertical needle, having a head upon it. A screw is cut upon this needle, and it takes it into a thread in the hole of the case through which it passes. This needle is a little longer than the case, and by turning its head it can be made to enter the pattern and thus steady the instrument. When the angle is to be changed, or the instrument closed, the points of the needles are withdrawn into the case, by turning their heads. By placing a pattern or design to be copied for sewed muslin work, or for printing so as to enlarge it, the pattern is placed on the table between the leaves of this case, and it is reflected from its polished reflectors upon a piece of prepared paper, set in proper relative position to receive it above. It is a convenient instrument for those engaged in enlarging intricate designs for manufacturing purposes.

NEW MODE OF LIGHTING THEATRES.

A new mode of lighting theatres has been introduced into the Imperial Opera, at Paris, which appears to be a most excellent improvement. The gas burners of the stage are placed under the floor, and the products of combustion are carried off by glass chimneys and ventilating tubes extending to the roof. The luminous rays are collected by a double reflector, and transmitted towards the stage by an inclined opening. A piece of unpolished glass placed before this opening modifies the glaring effect of the light reflected from the polished surface of the reflector. The combustible dresses of the actresses cannot come in contact with any of the gas jets thus arranged, and thus one cause of accidents is removed; while the heat and poisonous products of combustion are, at the same time, carried off by the arrangement of the gas jets.

COLOR OF WATER.

Water is usually considered to be colorless; the blue or green color noticed when it is in large masses being attributed to impurities. From some experiments of Dr. Tyndall, which were recently exhibited at the Royal Institution by Dr. Frankland, it has been proved

that water is not so colorless as might be supposed. A tin tube, fifteen inches long and three inches in diameter, was placed horizontally on a stand, and half filled with water. The tube was closed by plate-glass at each end, and a beam of electric light thrown through it. By this means an image of the contents of the tube was projected on a white screen. That portion of the tube which was filled with air allowed the rays to pass through unchanged in color, when they formed a white semi-circle on the screen; but the rays which passed through the stratum of water were seen to have had a greenish blue color communicated to them. The color was found to vary from a pure green up to a blue, according to the purity of the water. It is thus evident that the color of water is very appreciable; for, in a thickness of only fifteen feet, it exhibits a very considerable amount.

Dr. G. C. Wittstein, in a paper read before the Bavarian Academy on the color of water as found in nature, sums up as follows: —

Pure water is not colorless, but of a blue tint, which is not altered by the mineral ingredients present. Any deviation from the blue color is caused by organic substances, of the class termed ulmic acids, held in solution by alkalies. In proportion to the quantities of these organic salts the color reaches from a bluish green to yellow and brown. The amount of alkali determines of course the solubility of ulmin and the shade of color, and is itself dependent on the nature of the bed or rock with which the water comes in contact. As a general rule it may be assumed that running water is the softer the nearer its color approaches brown, and the harder as it becomes blue.

SUBAQUEOUS EXPLORATIONS.

A lorgnette for subaqueous exploration has been prepared by Dr. C. M. Cresson, of Philadelphia. Its peculiarity consists in placing a Nicol's prism of Iceland spar between the object-glass and the eye-piece, which removes the greater part of the bright light reflected from the surface of the water, and thus renders objects beneath water more distinctly visible.

THE THREE PRIMARY COLORS.

The following is an abstract of a lecture on "The Theory of the three primary Colors," delivered by Prof. J. Clark Maxwell, of King's College, London: —

Colors may be considered in their relation to the arts, to optics, and to physiology. By mixing various pigments the artist is enabled to imitate the colors of nature, and to that object his study of colors is limited. The researches of the optician and physiologist have a far wider field. The foundation of the theory of the composition of colors was laid bare by Newton; he showed that every color in nature is procured by the mixture in various proportions of the different kinds of light into which white light is divided by refraction. By means of a prism he obtained a spectrum, consisting of seven colors — red, orange, yellow, green, blue, indigo, violet; of these, red, blue, and green have been termed primary. By means of a prism we can

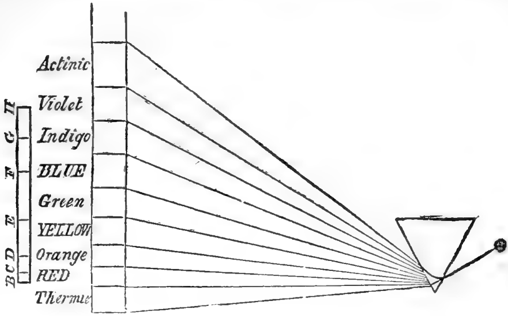
analyze any colored light, and determine the proportions in which the different homogeneous rays enter into it, and by means of a lens we can recombine the rays and produce the original colored light. Newton devised a plan for finding out the colors of a compound, the quantity and quality of each color being given. Dr. S. Young originated a theory that the three elements of color are determined as much by the constitution of the sense of sight as by anything external to us. He conceived that three different sensations may be excited by light, but that the proportion in which each of the three is excited depends on the nature of the light; and conjectured that these three primary sensations correspond to red, green, and white. Sir David Brewster regards the actual colors of the spectrum as arising from the intermixture of three primary kinds of light — red, yellow, and blue. Prof. Clark Maxwell, after referring to the above theories, proceeded to explain the instrument by which he had prosecuted his researches. It consisted of a long box or tube, fitted with a lens, and having adjustments for producing slits varying in width, whereby he was enabled to separate any parts of the spectrum, and recombine them. By means of this instrument he has been enabled to ascertain that mixtures of the blue, red, and green rays produce white; blue and red, purple; red and green, yellow, — but if the red predominates, orange; while yellow and blue produce white instead of green, as in the case of pigments. Professor Maxwell has verified, and is still endeavoring to verify, his results, by obtaining not only the observations of persons of ordinary vision, but also of persons wholly or partially color-blind. He has arrived at the following among other conclusions: That there are three colors in the spectrum, red, green, and blue, by the mixture of which colors chromatically identical with the other colors of the spectrum may be produced; that the orange and yellow of the spectrum are chromatically equivalent to mixtures of red and green; that yellow has no pretension to be considered a primary color. These conclusions were experimentally illustrated by means of the electric lamp, and by the apparatus expressly devised for the purpose by Professor Maxwell himself.

SPECTRUM ANALYSIS.

Of all the contributions made to science during the last few years, none are probably more important and generally interesting than those which have recently resulted from the application (if not discovery), by MM. Bunsen and Kirchhoff, of Germany, of the so-called process of "spectrum" or "photo-chemical" analysis. Before proceeding, however, to notice in detail the results attained to by these scientists, it is necessary, at least for the non-professional reader, to briefly refer to certain well-known and long-established principles in optical science.

When a ray of solar light is intercepted by, and caused to pass through, a prism, it is refracted, and forms, when thrown upon a wall or screen, a broad band of colored lights, which is known as the pris-

matic or solar spectrum. (See figure.) When the solar spectrum is received upon a white screen, it appears at first glance to be a continuous band of colored light (red, orange, yellow, green, blue, indigo,

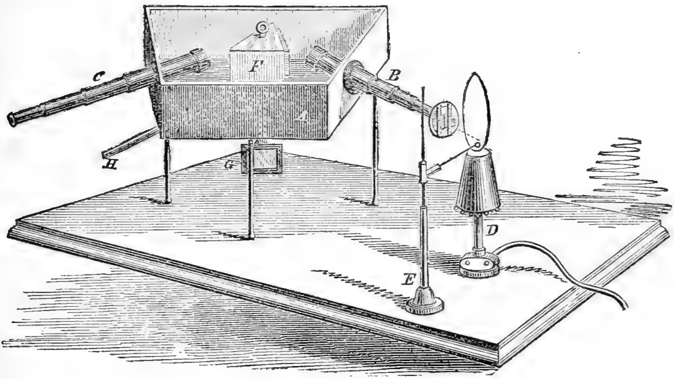


and violet); but by taking certain precautions, the luminous band may be seen in reality to be traversed in the direction of its breadth by numerous dark lines, varying, however, in different parts, in width and distinctness; these lines are independent of the nature of the refracting medium used, and they always occur in the same color and at corresponding parts of the spectrum. The position of some of the most conspicuous lines observed in the solar spectrum was long ago accurately determined by Fraunhofer, who designated them by the letters *B*, *C*, *D*, *E*, *F*, *G*, and *H*, as represented in the figure. It has also been long known that the position of these dark lines varies with the source of the light yielding the spectrum; the spectrum yielded by solar light having one system of lines, and the spectrums from other or artificial lights having other systems or peculiarities.

It is at this point that the investigations of Messrs. Bunsen and Kirchhoff may be properly said to have commenced. They found that when a metallic or other elementary substance is burned or *evaporated* in a gas flame, and the light of the flame is passed through a prism and refracted to form a spectrum, the spectrum so formed has bright lines crossing it, which are peculiar to or characteristic of the metal or element present in a state of vapor in the flame yielding the light; or, in other words, the light from one metal or element will present lines in one part of its spectrum, and that from another metal lines in a different part; the light of each metal or element having always its own characteristic lines with invariable uniformity. The German philosophers have also satisfied themselves that the appearance of these peculiar lines in the several spectrums may be regarded as absolute proof of the presence in the flames of certain metals, and that they serve as reactions, by means of which these bodies may be recognized with more certainty, greater quickness, and in far smaller quantities than can be done by help of any other known analytical method, no matter what may be the nature of the body with which the metals are combined.

The lines of the spectrum show themselves most plainly when the temperature of the flame is highest and its illuminating power least; hence a hydrogen gas burner, which gives a feeble illumination with great heat, is best adapted for the purpose of experimenting.

The apparatus employed by Messrs. Kirchhoff and Bunsen in their observations is thus described in *Poggendorff's Annalen.* (See figure.)



A is a box blackened on the inside, having its horizontal section in the form of a trapezium, and resting on three feet; the two inclined sides of the box, which are placed at an angle of about 58° from each other, carry the two small telescopes B and C. The eye-piece of the first telescope is removed, and in its place is inserted a plate, in which a slit made by two brass knife-edges is so arranged that it coincides with the focus of the object-glass. The gas lamp D stands before the slit in such a position that the mouth of the flame is in a straight line with the axis of the telescope B. Somewhat lower than the point at which the axis of the tube produced meets the mouth, the end of a fine platinum wire bent round to a hook is placed in the flame. The platinum wire is supported in this position by a small holder, E, and on to the hook is melted a globule of the metal or salt of the metal which it is desirable to examine. Between the object-glasses of the telescopes B and C is placed a hollow prism, F, filled with bisulphide of carbon, and having a refracting angle of 60°; the prism rests upon a brass plate, movable about a vertical axis. The axis carries on its lower part the mirror G, and above that the arm H, which serves as a handle for turning the prism and mirror. A small telescope placed some way off is directed toward the mirror, and through this telescope an image of a horizontal scale fixed at some distance from the mirror is observed. By turning the prism round, every color of the spectrum may be made to move past the vertical wire of the telescope C, and any required position of the spectrum thus brought to coincide with the vertical line. Each particular portion of the spectrum thus corresponds to a certain point on the scale. If the luminosity of the spectrum is very small, the wire of the telescope C may

be illuminated by means of a lens, which throws a portion of the rays from a lamp through a small opening in the side of the tube of the telescope C.

The metals experimented on by Messrs. Bunsen and Kirchhoff are used in the form of chlorides purified with the greatest care. When these are introduced into a jet of flame they volatilize to a greater or less extent, and then communicate to the flame the special character above alluded to.

Of the wonderful delicacy of this new method of analysis, our readers may obtain a realizing sense from the following description of an experiment which a recent writer describes as witnessing in Prof. Bunsen's laboratory. In a far corner of the experiment room, the capacity of which was about 60 cubic metres (1 cubic metre = 35.3 cubic feet), was burnt a mixture of 3 milligrammes (0.0462 gr.) of chloride of sodium (common salt), whilst the spectrum of the flame was observed through the slit of the telescope. Within a few moments, when the vapor has time to diffuse itself throughout the lamp flame, a bright and distinct yellow line was seen to cross the spectrum, which remained visible for a few minutes and then disappeared. This was the sodium line; for whenever sodium is present in the atmosphere of the lamp flame, and however combined with other substances, that particular line never fails to appear. In this experiment, it was calculated, from the weight of the sodium salt burnt, and from the capacity of the room, that there was present, suspended in one part by weight of air supplied to the flame, less than one 20,000,000th of a part of chloride of sodium vapor. But as the reaction of the sodium on the spectrum could be easily observed in one second, and as in this time the quantity of air heated by the flame could be calculated from the rate of issue from the flame, and from the composition of the flame, the surprising result was arrived at that the eye, in this experiment, was able to recognize with the greatest ease the presence of the three-millionth part of a milligramme of chloride of sodium. It must not, therefore, be a matter of surprise to find sodium distributed almost everywhere, especially in the atmosphere, in which is almost always a sufficient quantity to show the sodium ray. The same may be also said in a great measure of the rare metal lithium, which gives two sharply-defined lines — the one a very weak *yellow* line, and the other a bright *red* line, both toward the extreme end of the solar spectrum.

In regard to the sensibility of the lithium reaction in the spectrum analysis, it is stated that in a room of a capacity of about sixty cubic metres was exploded a mixture of sugar-of-milk and chlorate of potassa, containing nine milligrammes of carbonate of lithia. The lamp, being placed at some distance off, became quickly colored, so that the red ray could be distinctly visible in the spectrum. The authors estimated that this sensibility reached the nine-millionth part of the amount taken.

Messrs. Bunsen and Kirchhoff found in their experimenting, greatly to their surprise, that lithium, instead of being a very rare substance, was one of the most widely distributed of the elements. They found it in the water of the Atlantic; in the ashes of marine plants; in pure spring water; in the ashes of tobacco, vine leaves, and of grapes;

and even in the milk of animals fed on crops growing in the Rhine plain, on a non-granite soil, and in the human blood. In the mother-liquors of tartaric acid manufactories, the lithia is found to be so concentrated as to be worth commercial extraction; and the same may be said of certain mother-liquors of saline springs.

The spectrum reaction of potassium is not nearly so delicate as that of sodium; its spectrum yielding only two characteristic lines, one in the outermost *red*, and the other far in the *violet* ray of the solar spectrum—points at which the eye ceases to be sensitive to the rays. The presence, however, of one thousandth of a milligramme of the metal could be readily detected.

The rays shown by the chlorides of barium, strontium, and calcium are more complicated than those afforded by potassium, sodium, and lithium, and require a somewhat experienced eye for their identification.[1] They are, however, quite distinct enough to be easily recognized, even when salts of these metals are mixed together; for the great advantage of this method of analysis is, that foreign matters have no influence on the results, the chemists being able to detect with certainty the different elements in a mixture containing the tenth of a milligramme of the metals mentioned above. Sodium, with its yellow ray, first appears; after that the well-defined red ray of lithium; next is seen the paler rays indicating potassium; and, after these rays have disappeared, they are replaced by those of calcium and strontium, which remain visible for some time. The absence of one or other of these sets of rays shows the absence of the corresponding metals.

We are, then, by this method, placed in possession of an analytical process of the most extraordinary delicacy, and can by means of it easily make a qualitative analysis of a compound containing several elements. Thus Messrs. Bunsen and Kirchhoff have been enabled to exhibit the reactions of *potassium*, *sodium*, *lithium*, *calcium*, and *strontium*, in several mineral waters; to show the bands of *sodium*, *potassium*, *lithium*, and *calcium* in the ash of a cigar moistened with hydrochloric acid, and to point out differences in the composition of various limestones.

New Metals.—But the greatest triumph of Bunsen's and Kirchhoff's new method of analysis, was the discovery of two new metallic elements, belonging to the group of alkali metals. While working on the residue of a mineral water from Kreuznach, in Germany, a spectrum was obtained which gave lines as simple and characteristic as those of lithium and sodium, but which were *blue*, and were not refera-

[1] The spectrum yielded by a flame containing the vapor of strontium is characterized by the absence of green lines. It contains, however, eight remarkable lines, namely, six *red*, one *orange*, and one *blue*. To examine the intensity of the reaction, Kirchhoff and Bunsen threw up into the air of the room, in the form of fine dust, 0.077 grm. of chloride of strontium, and thoroughly mixed the air by rapidly moving an umbrella; the lines immediately came out and indicated the presence of the six-hundred-thousandth part of a milligramme of strontium. The *barium* spectrum is distinguished by two very distinct *green* lines, by which the authors were enabled to detect with certainty one thousandth of a milligramme of metal. Calcium gives a very broad and characteristic *green* line, and, moreover, a bright *orange* line lying near the red end of the spectrum. Six ten-millionths of a milligramme of the chloride of this metal could be easily detected.

ble to any known element. The indefatigable experimenters, acting on the testimony thus obtained, evaporated down no less a quantity than twenty tons of the mineral water in question, and obtained from the residuum two hundred and forty grains of the platinum salt of a new metal which they have named CÆSIUM, from the Latin word *cæsius*, signifying grayish-blue, that being the tint of the two spectral lines which it shows. Further investigations showed the presence of cæsium in other mineral waters, and led to the detection of another element, which, from the circumstance of its yielding two very dark red spectral lines, has been termed RUBIDIUM, from the Latin *rubidus*, dark red. Both of these metals resemble potassium so closely that they cannot be distinguished from it by the usual re-agents, or before the blowpipe. Their presence in minute quantities can only be recognized by aid of the new method of spectral analysis.

Properties of the new Metals. — Cæsium appears to be the constant companion of rubidium, and has thus far been found most abundant in the saline waters of Dürkheimer, in Germany. The atomic weight of cæsium is 123.4 ($H=1$): Symbol, Cs. It is the most electro-positive of all known elements.

Caustic cæsia resembles caustic potash; carbonate of cæsia is soluble in alcohol, in which reaction it differs from the carbonate of rubidia; sulphate of cæsia forms alum with the sulphate of alumina. Chloride of cæsium is deliquescent like the chloride of lithium.

Messrs. Bunsen and Kirchhoff have found traces of rubidium in almost all mineral waters; but it exists in greatest quantity in the mineral known as lepidolite; some of which, from Moravia, was found to contain about $\frac{2}{1000}$ths of its weight of the oxide of rubidium. The atomic weight of it is 85.36 ($H=1$): Symbol, Rb.

Caustic rubidia resembles caustic potash; carbonate of rubidia is insoluble in alcohol; it can be readily converted into bicarbonate. Nitrate of rubidia varies from nitrate of potassa in crystalline form. Sulphate of rubidia is isomorphous with sulphate of potassa, and forms cubic alum with the sulphate of alumina. Chloride of rubidium crystallizes in cubes.

Another new element, Thalium. — Mr. William Crookes, an English chemist, also announces the discovery, by means of the photo-chemical process of analysis, of another new element, belonging to the sulphur group, to which he gives the name Thalium — Gr. *θαλλος*, green, from the circumstance of its yielding an intensely green spectral ray. Thus far the new element has been obtained in the form of a dense brown powder, from specimens of native sulphur. Its physical and chemical properties have not, however, as yet been described.

It is scarcely possible to overrate the probable importance to chemical science of this new and beautiful method of analysis. In fact, the discoveries of Bunsen and Kirchhoff seem to herald the birth of a new kind of terrestrial and *stellar* chemistry, inasmuch as it extends almost to infinity the limits within which the chemical characteristics of matter have hitherto been confined. "In spectral analyses," observe the discoverers of the process, "the colored bands are unaffected by any alteration of physical conditions, or by the presence of other bodies. The positions, therefore, which the lines occupy in the spectrum, indicate the existence of a chemical property as unalterable as

the combining weights themselves, and may accordingly be estimated with an almost astronomical precision."

New Instrument for Spectral Analyses. — A new instrument for exhibiting the fixed lines in spectra, from different sources, far more simple than that made use of by Messrs. Bunsen and Kirchhoff, has been described by M. Mousson in Poggendorff's *Annalen*, under the name of the *Spectroscope.* The apparatus consists essentially of a tube blackened internally, and having at one extremity a plate of metal, with an adjustable slit for the admission of light. The prism is placed at the other extremity of the tube, so that the eye of the observer may be brought close to its second refracting surface. The tube is attached to an appropriate stand, so that it may be conveniently directed to the light to be examined; and the eye of the observer is protected from extraneous light by a small screen of metal attached to the tube. The edges of the slit must be ground perfectly true. This apparatus does not require a darkened chamber or delicate and difficult adjustments. In a communication to *Silliman's Journal*, July, 1861, Prof. Wolcott Gibbs states that it can be obtained in New York city of Mr. Chas. Sacher; price twenty-five dollars.

RESEARCHES BY MEANS OF THE PROCESS OF SPECTRUM ANALYSIS ON THE CONSTITUTION OF THE SOLAR ATMOSPHERE.

M. Kirchhoff, following up the line of investigation described in the foregoing article, has recently applied the process of photo-chemical analysis to the study of the constitution of the sun's luminous enveloping atmosphere. He maintains, as the result of examinations, that the sun has an ignited gaseous atmosphere, which encloses a core of still higher temperature. If we could see the spectrum of this atmosphere, we should detect the bright lines which are characteristic of the metals existing in it, and should recognize the metals themselves from these. The more strongly luminous body of the sun does not, however, permit the spectrum of his atmosphere to appear. It inverts this spectrum; so that instead of the bright lines which the spectrum of the atmosphere alone would exhibit, dark ones make their appearance. We see, therefore, only the negative image of the spectrum of the sun's atmosphere.

In order to study the solar spectrum with the requisite degree of accuracy, Kirchhoff procured from the workshop of Steinheil an apparatus consisting essentially of four large flint-glass prisms and two telescopes.

With this apparatus the spectra are seen in a hitherto unattainable degree of distinctness and purity. It exhibits in the solar spectrum thousands of lines, with such clearness that they are easily distinguished from each other. It is the author's intention to draw the whole spectrum, as seen with his apparatus, and he has already done this for the portion which lies between Fraunhofer's lines D and F.

This apparatus exhibits the spectrum of an artificial source of light with the same distinctness as the solar spectrum, provided only that the intensity of the light is sufficient. A common gas-flame, in which a metallic compound evaporates, is usually not sufficiently luminous,

but an electric spark gives with the greatest distinctness the spectrum of the metal of which the electrodes consist. A large Ruhmkorff's induction-coil yields electric sparks in such rapid succession that the spectrum can be observed as easily as that of the sun.

A very simple arrangement permits the comparison of the spectra of two sources of light. The rays of one of the sources may pass through the upper half of the vertical slit, while those of another pass through the lower half. When this is the case, one of the two spectra is seen immediately beneath the other, and it is easy to determine whether coincident lines occur in both.

In this manner the author satisfied himself that all the bright lines peculiar to iron correspond to dark lines in the solar spectrum. In the portion of the spectrum between D and F, about seventy particularly well-marked lines occur, resulting from the iron in the sun's atmosphere.

Iron is remarkable on account of the great number of distinct lines which it produces in the solar spectrum. Magnesium is interesting because it produces the group of Fraunhofer's lines lying in the green denoted by Fraunhofer by *b*, and consisting of three very strong lines. Very distinct dark lines in the solar spectrum correspond to the bright lines produced by chromium and nickel, and we may, therefore, regard the presence of these substances in the sun's atmosphere as proved. Many other metals appear, however, to be wanting in the sun's atmosphere. Silver, copper, zinc, lead, aluminum, cobalt, and antimony have extremely brilliant lines in their spectra; but no distinct dark lines in the solar spectrum correspond to these.

Many metallic compounds do not give in a gas-flame the spectrum of their metal, because they are not sufficiently volatile. In these cases the spectrum may be made to appear by means of the electric spark. It is true that in this case the spectrum of the metal of which the electrodes consist and that of the air in which the spark passes is also seen. To avoid the difficulty arising from the very great number of bright lines of which the spectrum of every electric spark consists, it is necessary to have recourse to a particular arrangement. The electric spark is allowed to pass at the same time between two similar pairs of electrodes, the light of one spark being allowed to pass through the upper, that of the other through the lower half of the slit, so that one spectrum is seen above the other. When the two pairs of electrodes are clean, the two spectra are perfectly similar; when, however, a metallic compound is placed upon one pair, the corresponding spectrum immediately shows the lines belonging to the metal introduced. The author has satisfied himself that in this manner even the metals of the rare earths, yttrium, erbium, terbium, etc., may be recognized most quickly and certainly. It is, therefore, to be expected that, by the help of Ruhmkorff's apparatus, the spectral method of analysis may be extended to the detection of all metals. The researches which the author has undertaken, in connection with Bunsen, will, it is hoped, determine this point.—*Journ. für Prakt. Chimie.*

PHOTOGRAPHS OF SPECTRAL LINES.

At the last meeting of the British Association (1861), Prof. Miller exhibited photographs of various spectra, and read a paper on the subject. The apparatus by which the spectra may be photographed consists of an ordinary camera obscura attached to the end of a long wooden tube, which opens into a cylindrical box, within which is a prism glass, or a hollow prism filled with bisulphide of carbon. If the prism be so adjusted as to throw the solar rays, reflected from a heliostat, upon the screen of the camera, and the wires which transmit the sparks from a Ruhmkorffer coil are placed in front of the uncovered portion of the slit, the two spectra are simultaneously impressed. The solar beam is easily intercepted at the proper time by means of a small screen, and the electric spectrum is allowed to continue its action for two or three, or six, minutes, as may be necessary. He did not find that anything was gained in distinctness by interposing a lens of short focus between the slit and the wire which supplied the sparks, with the view of rendering the rays of the electric light parallel like those of the sun, owing to the absorbent action of the glass weakening the photographic effect; and the flickering motion of the sparks being magnified by the lens, rendered the lines less distinct than when the lens was not used. Although with each of the metals,—including platinum, gold, silver, copper, zinc, aluminum, magnesium, iron,—when the spark was taken in air, he obtained decided photographs, it appeared that in each case the impressed spectrum was very nearly the same, proving that few of the lines produced were those which were characteristic of the metal. The peculiar lines of the metal seemed chiefly to be confined to the visible portion of the spectrum, and these had little or no photographic power. This was singularly exemplified by repeating the experiment upon the same metal in air, and in a continuous current of pure hydrogen. Iron, for example, gave, in hydrogen, a spectrum in which a bright orange and a strong green band were visible, besides a few faint lines in the blue part of the spectrum. Although the light produced by the action of the coil was allowed to fall for ten minutes upon a sensitive collodion surface, scarcely a trace of any action was procured; whilst, in five minutes, in the air, a powerful impression of numerous bands was obtained. It was remarked by Mr. Talbot that in the spectra of colored flames the nature of the acid did not influence the position of the bright lines of the spectrum, which he found was dependent upon the metal employed, and this remark has been confirmed by all subsequent observers. But the case was very different in the absorptive bands produced by the vapors of colored bodies; there the nature of both constituents of the compound was essentially connected with the production of absorptive bands. Chlorine, combined with hydrogen, gave no bands by absorption in any moderate thickness. Chlorous acid and peroxide of chlorine both produced the same set of bands, while hypochlorous acid, although a strongly-colored vapor, and containing the same elements, oxygen and chlorine, produced no absorptive bands. Again, the brownish-red vapor of perchloride of iron produced no absorptive bands; but when converted into vapor in a flame, this gave out bands independent of the form in which it occurred com-

bined. These anomalies appeared to admit of an easy explanation on the supposition that, in any case, the compound is decomposed in flame, either simply by the high temperature, just as water is, as shown by Grove, or, in all other cases of the production of bright lines by the introduction of a metallic salt into a flame of burning bodies, as shown by Deville. In the voltaic pile the decomposition must of necessity take place by electric action. The compound gases, protoxide and binoxide of nitrogen, gave, when electrified, the same series of bright bands, as Plücker had shown, which their constituents when combined furnish. Aqueous vapor always gives the bright lines due to hydrogen and hydro-chloric acid, the mixed system of lines, which could be produced by hydrogen and chlorine. The reducing influence of the hydrogen and other combustible constituents of the burning body would decompose the salt, liberating the metal, which would immediately become oxidized or carried off in the ascending current. There was obviously a marked difference between the effect of intense ignition upon most of the metallic and the non-metallic bodies. The observations of Plücker upon the spectra of iodine, bromine, and chlorine show that they give, when ignited, a very different series of bands from those which they furnished by absorption. But it was interesting to remark that in the case of hydrogen, which, chemically, was so similar to a metal, we have a comparatively simple spectrum, in which the three principal bright lines correspond to Fraunhofer's dark lines, C, F, and G.

PRACTICAL VALUE OF THE STEREOSCOPE.

A novel application of the stereoscope was announced a year or two ago by Prof. Dové, of Berlin. It consists in the detection of reprinted matter in the case of books, pamphlets, etc., and was based upon the impossibility, or at least extreme difficulty, of compositors, when setting up a page of type with the intention of producing a fac-simile of a page of printed copy, making the blank spaces between the separate words in a line exactly the same width in the copy as in the original. Our readers may not all be aware that the blank spaces between the words which they are now looking at are made by placing very thin strips of lead or type-metal, technically called "spaces," side by side between each group of types forming a word, and so arranging them as to obtain each line of the proper length. These lead "spaces" are so thin that in ordinary work it is never attempted to get exactly the same number between each word, but they are put in in greater or less number, according to the way in which the words fall at the end of a line; that is to say, if the line, as it is set up in type, falls a trifle short of the proper length, it is "spaced out;" and if it exceeds that length by a letter or two, some of the "spaces" are removed, or thinner ones used. In this manner it will be perceived that however accurately the compositor follows the words of his printed copy, and sets up his page in imitation of the original, he is sure to be sometimes incorrect with the spacings between the words. A knowledge of these facts led Prof. Dové to imagine that if a stereoscopic slide were so mounted as to have the original printed page on one side and the recomposed fac-simile on the other half, an inspection in the instrument would at once detect the reprint. And so it was seen to be on trial. The page of print

which the eye apparently saw formed by the superposition of the two stereoscopic corpulæ presented the remarkable appearance of not being on the same flat surface; nearly every alternate word started up or retreated to a different plane from its neighbor; and the whole effect was most strange and disjointed, as if the observer were looking at three or four superposed sheets of glass, with the words forming the page dotted at random on different sides of the glass plates.

Pursuing the train of investigation thus suggested, Prof. Dové has been led to further discoveries. It is known that wires of different metals, drawn through the same plate, are not all of the same thickness, for they are of different degrees of elasticity, and after being drawn through the plate they expand to different amounts. This expansion is proved by the fact that, with the exception of gold, no wire can be drawn through the same aperture through which it has been pressed. Silver requires the least force, but the expansion caused by elasticity continues for several weeks. It appeared probable to Prof. Dové that in stamping metals something similar would take place, and that medals of different metals, stamped in the same die, would be of different sizes. This would be most readily seen in those medals in which the impression is symmetrically arranged in reference to the edge, as is the case with the medals of the French Exhibition, in which the coat of arms encircle the French eagle in the middle. One of these in silver and one in bronze were placed in the stereoscope, the eagle being fixed in the middle. After some time the stereoscopic combined medals were seen in the form of a hollow escutcheon, and of the color of an alloy of the two metals. Evidently the reason of this lies in the nonius-like shifting of the individual lines of the impression. This same result was also obtained by the Professor with large gold and silver medals, which were kindly entrusted to him by the royal mint in Berlin. It was probable that medals obtained by casting would show the same thing, and this was found to be the case with tin, bismuth, and lead. Hiero's crown led to the discovery of specific gravity to detect an adulteration. The stereoscope may now be used for the same purpose.

PERSISTENT ACTIVITY OF LIGHT.

M. Niepce St. Victor, the celebrated French photographist and chemist, has recently communicated to the Academy some additional researches respecting what he calls "the persistent activity of light." He exposed to the influence of bright sunlight for three hours a piece of porcelain plate, then he removed it and laid it upon a piece of paper which had been prepared with chloride of silver. Some parts of the paper were intentionally not laid under the porcelain, for the purpose of discovering what would be the difference, if any, between the covered and uncovered parts. After twenty-four hours had elapsed, the porcelain was removed, and the paper examined, when it was found that the silver salts were reduced in that part of the paper which had been placed under the porcelain, but no effect was produced in the paper which had not been covered. This led him to conclude that solar light communicated activity to some bodies, which they retained after exposure to the sun's rays. He then tried experiments with a steel plate, one part of which was polished and another part made

rough on the surface with strong nitric acid, then washed with alcohol and dried. This plate was exposed to the sun's rays for three hours, and then one half of the polished part of it, and one half of the rough part, were placed under an opaque screen, with the other portions under a piece of transparent glass. The plate was then laid upon albumenized paper prepared with chloride of silver. After twenty-four hours' contact — the same time as with the porcelain — an impression of the unpolished portion of the steel plate, acted upon by the light, was obtained; but none from the polished part, nor from the unpolished portion which had been placed under the opaque screen.

A strip of glass ground or roughened on the surface, and cleaned with distilled water, gave the same results as the steel plate; but under a violet-colored glass, the light had less action than under a white glass.

In a paper upon this subject, M. Niepce de Saint Victor says: —

It has frequently been announced that light magnetizes a bar of steel; but after removing every source of error, I have found it impossible to make a needle, solarized for a very long time under the rays of light concentrated by a strong lens, attract another sewing needle suspended by a hair, whether the light was white, or colored by being made to pass through a violet-colored glass.

I have also enveloped a needle in paper impregnated with nitrate of uranium, or with tartaric acid, and solarized; I have also suspended a needle horizontally in tubes containing solarized cardboard, and the results were invariably of a negative character; which proves that the activity of which I have spoken above is not due to electricity, as some experimentalists have pretended.

I afterward repeated the first experiments upon needles very feebly magnetized, to see if I could de-magnetize them; but the results were always negative.

From which I conclude that this persistent activity given by light to all porous bodies, even the most inert, in all my experiments, cannot even be phosphorescence. It is, therefore, most probably a radiation invisible to our eyes, which acts like a gas, since it does not pass through glass.

NEW APPLICATIONS OF PHOTOGRAPHY.

Important Discovery in Photographic Science. — Signor Balsamo Prof. of Physics, University of Lucca, Italy, has found a substitute for nitrate of silver, in the positive printing of photographs, viz., hydrochloric acid saturated with phosphorus, and diluted with acetate of copper. Paper imbued with this compound is exposed to the action of light under a negative, and when it has acquired a gray color, it is removed from the pressure-frame and exposed for five minutes to the vapors of sulphuretted hydrogen, which acts upon those parts of the paper which have become altered by the action of light. The picture is afterward toned and fixed in a solution of nitrate of bismuth. A decomposition of the salt of copper takes place, and the image, which is permanent, is formed of oxide of bismuth.

Photographic Printing. — Mr. Sutton, an English photographist, proposes the following method of transferring a photograph upon wood

in order to engrave the design afterwards: Prepare the block as usual by coating it with some white substance, ground with gum and water; also take a negative proof of the photograph in question, and get a positive impression from it on paper prepared with charcoal, according to M. Poncy's process. This impression, previously moistened with an alcoholic solution of caustic potash of moderate strength, is now laid, face downwards, on the block, and pressed upon the white surface by friction with an ivory knife or burnisher. On removing the paper, the design will be found clearly impressed on the block.

Photography applied to Anatomy. — An important scientific work is in course of issue in Munich — a Photographic Atlas of the Nervous System of the Human Frame. The photographs are taken by Herr Albert, the court photographer, and are done with clearness and precision. There is an explanation published with the plates, in German and French, by a professor of anatomy; and the work is to be completed in ten parts, each part containing five plates, and costing about eleven shillings and sixpence. The first part is published, containing the nerves of the head, which stand out as plain and fine as a spider's web, in the photograph. The importance of such a work for students of anatomy can hardly be exaggerated.

Ingenious Application of Photography. — On the Chicago and Milwaukie Railroad a very beautiful application of the photographic art is used on the "season passes" and "commutation tickets" to prevent their illegal transfer. When a person applies for a season pass or ticket, he incloses his photograph, taken on a small gummed label, and this is pasted on the card which he receives. The conductor of the train can thus see at a glance whether the bearer of a pass or ticket carries the evidence of "the right man being in the right place."

Photographs of Defaced Writing. — M. Silvy, of Paris, has recently reproduced photographically one of the curious old manuscripts of early literature. He states that not only is the copy more legible than the original, but certain passages which could not be deciphered on the old parchment have been actually revived; and this is particularly visible on the last page, where a note, written in German under the signature, has become both visible and legible, while there is not a trace of it left on the original. This curious circumstance is explained as follows: — "During the photographic process, the brilliant and polished parts of the parchment reflect light much better than those where the ink has been deposited. However colorless it may appear, the ink has not lost its anti-photogenic qualities, opposed to the photogenic ones of the parchment; and, thanks to this opposition, black characters may be obtained on the sensitive surface, in return for much paler ones on the original."

Microscopic Photography. — Professor Gerlach, of the University of Erlangen, has obtained some photographs of microscopic objects by a new method, which consists in taking the object itself as the negative image, and then taking a magnified positive of this image, and repeating the operation, alternately positive and negative, until an image is obtained of such a size as to present details of structure far exceeding in magnitude those obtainable by the most powerful microscopes at present in use.

The Sun's Autobiography. — Mr. Godard, an English photographer,

has invented an apparatus by which a pencil of the sun's rays is directed upon a sheet of photographic paper, and as the sun makes his daily journey, the varying effect of his light on the paper is recorded by varying depths of shade. It is proposed to have this record kept through the year, and through a series of years, and thus compel the sun to tell us in his own handwriting whether he preserves undiminished the fires of his youth, or is fading away in a gradual decline.

Photographs of the Sun's Surface. — At the last meeting of the British Association (1861), Prof. Airy, the astronomer royal, called attention to a large photograph of the sun, which he had on exhibition, and especially to the rapid shading off of the intensity of the light towards the outside of the sun's disk. He and the late M. Arago had differed on this very point, — M. Arago maintaining that the intensity of the sun's light must increase towards the edge of the disk, while he, the astronomer royal, ventured to maintain the contrary opinion. Here, by this very ingenious process by which Mr. De La Rue had succeeded in photographing the sun's disk, it became palpable that his opinion was in accordance with the fact in nature, while that of M. Arago cannot any longer be maintained. The photographed fact settles the question.

Photography as a Reformatory Agent. — A novel and interesting application of the art is now in daily use at the famous Mettray colony, near Tours, which is the first and most celebrated reformatory establishment in France for young convicts. Every urchin brought to this house of correction has his portrait taken the moment he sets foot in it, and another is made on the day of his leaving. The first represents the rags, dirt and misery, the physical and moral degradation, the prematurely careworn features, the scowling, cowering, timid, uneasy and withal ferocious look of the born thief. The second shows the same individual transformed by the magic of judicious discipline, which includes physical comfort and kind treatment. His dress is now clean and neat, and his countenance is redolent of health, contentment, benevolence and energy.

NEW METHOD OF PRODUCING ON GLASS PHOTOGRAPHIC OR OTHER PICTURES IN ENAMEL COLORS.

At a recent meeting of the London Society of Arts, Mr. F. Joubert gave an account of a new method, devised by him, of producing on glass photographic or other pictures in enamel colors which promises to be of great practical utility. After reviewing the history of the manufacture of stained and painted glass, Mr. Joubert said: —

"Having been for many years professionally acquainted with printing in connection with the fine arts, and having observed the immense development the new art of photography has taken, it occurred to me that if a means could be found to print the photographic image on glass, as easily as it is done on paper, and through the agency of some chemical composition which would admit of employing ceramic or vitrifiable colors, and burning them in, a great result would be attained, and a new and considerable branch of industrial art might thereby be opened. Considering the numerous and vari-

ous attempts which have, from time to time, been made to introduce a substitute for glass-painting in the decoration of houses, I believe it can be said that a want was generally felt for supplying the growing taste for pictorial decoration; for glass-painting is an expensive process, and requires also a considerable time to obtain a perfect result. There is a process known as lithophany, or transparent china, or biscuit slabs, which are now made, in Germany principally, and some very good specimens can be seen; but although any kind of subjects, on a small scale, can thus be represented, and with a very good effect, the slabs are heavy and thick, and can never come into use as a substitute for glass-painting. Some few years ago, a new mode, which was then termed 'potichomany,' was introduced, which had for a short time very great success — I allude to the mode of pasting colored prints inside a large glass bowl, or jar, and applying a thin layer of plaster of Paris, in a liquid state, so as to fix the paper firmly, and create an opaque back-ground, by giving substance to the whole, when seen from a distance. Some very good specimens of this were obtained, and it afforded for a time an agreeable occupation to many a young lady. Another mode has also been tried, and some very pretty results produced, by applying prints obtained by lithochromy, or lithographic printing in colors, on a pane of glass, and varnishing them at the back with copal or some such varnish; these will for some time resist the effects of the weather when placed in a window; and this is perhaps the nearest approach to glass-painting in point of effect yet achieved, but practically it does not answer, for the varnish will not stand exposure to the weather from outside, and the constant cleaning glass requires renders it liable to be injured, so that the design soon perishes.

In the mode which is now for the first time introduced, no such danger or liability need be feared, since the color has been firmly fixed in the substance of the glass by fire, and, being composed of the same elementary materials, has become part of the glass itself, and can only be destroyed by the glass being annihilated by breakage.

In order that the process may be very distinctly understood, I shall now describe it by reading that part of my specification which relates to the placing the image on the glass, fixing it, and passing it through the fire.

For this purpose I proceed in the following way: A piece of glass, which may be crown or flatted glass, being selected, as free from defect as possible, is first well cleaned, and held horizontally while a certain liquid is poured on it. This liquid is composed of a saturated solution of bichromate of ammonia in the proportion of five parts, honey and albumen three parts of each, well mixed together, and thinned with from twenty to thirty parts of distilled water, the whole carefully filtered before using it. The preparation of the solution, and the mixing up with other ingredients, should be conducted in a room from which light is partially excluded, or under yellow light, the same as in photographic operating rooms, so that the sensitiveness of the solution may not be diminished or destroyed.

In order to obtain a perfect transfer of the image to be reproduced, the piece of glass coated with the solution, which has been properly dried by means of a gas-stove (this will only occupy a few minutes), is

placed face downwards on the subject to be copied in an ordinary pressure frame, such as is used for printing photographs.

The subject must be a positive picture on glass, or else on paper rendered transparent by waxing or other mode, and an exposure to the light will, in a few seconds, according to the state of the weather, show, on removing the coated glass from the pressure frame, a faintly-indicated picture in a negative condition. To bring it out, an enamel color, in a very finely-divided powder, is gently rubbed over with a soft brush until the whole composition or subject appears in a perfect positive form. It is then fixed by alcohol in which a small quantity of acid, either nitric or acetic, has been mixed, being poured over the whole surface and drained off at one corner.

When the alcohol has completely evaporated, which will generally be the case in a very short time, the glass is quietly immersed horizontally in a large pan of clean water, and left until the chromic solution has dissolved off, and nothing remains besides the enamel color on the glass; it is then allowed to dry by itself near a heated stove, and when dry is ready to be placed in the kiln for firing.

It may be stated that enamel of any color can be used, and that by careful registering, a variety of colors can be printed one after the other, so as to obtain a perfect imitation of a picture; also that borders of any description can be subsequently added, such as those shown in the specimens exhibited, without any liability to remove or even diminish the intensity of the color in the first firing.

It will be easy to perceive that this mode of obtaining an image on glass, in an absolutely permanent substance, and of any description, color, or size, may prove of considerable advantage and utility for the decoration of private houses, and also for public buildings. Now that, by means of the photographic art, the most correct views of any object or of any building or scene — even portraits — can be faithfully and easily obtained, I need only point out the usefulness of the mode of fixing those images, in an indelible manner, for ornamental as well as for scientific purposes.

In large cities, where houses are built so close to one another, in how many places may not the process become available, by enabling any one to introduce, for a very moderate expense, pleasing or instructive images where common plain ground glass is now used, to shut out the sight of a disagreeable object, a dead wall, or an unpleasant neighbor, without diminishing the amount of light more than is convenient. Even for domestic purposes, for lamps or screens, or any object in glass, the process will be found useful, especially on account of its rapidity, which will enable the manufacturer to execute and to deliver an order at a very few days' notice.

Discussion. — Mr. Harvey inquired whether the method now employed for coloring daguerreotypes was applicable to the process just described, provided the colors used were such as to stand the firing.

M. Joubert replied in the affirmative; mineral colors being used instead of vegetable colors, as in the case of photographic coloring. The difference between the two was this: where they applied the color to a photograph, or drawing upon paper, the color remained as applied; but any one acquainted with glass painting knew that various colors were acted upon differently under the action of heat in the

firing. For yellow color they used a preparation of silver and copper, and minerals were used more or less in the preparation of all the colors for burning in. If the colors were applied by the brush, as in the coloring of daguerreotypes, the process amounted, in fact, to that of glass painting, properly speaking, instead of its being a mechanical process, as this professed to be. His (M. Joubert's) object had been to bring this invention to a purely mechanical result, so as to obviate the necessity of employing artists for glass painting. The object of the invention was to reproduce photographs or designs in a perfect form by mechanical manipulation.

In regard to the size and colored variety of the pictures executed, M. Joubert said that the specimens he had exhibited, as being unburnt, twenty-four by seventeen and one-half inches, were the largest he had yet produced, but he apprehended the size was only limited by the dimensions of the kiln. There would, of course, be a little more care required in manipulating upon a large picture, but there would be no difficulty in producing a picture of three or four feet square.

In regard to the combination of colors capable of being burned at the same time, he could not, at present, give a definite opinion. The specimens exhibited were almost all of one color. He thought it better to produce them perfectly in monochrome in the first instance, and having mastered the difficulties of manipulation in one color, then to go to three or four colors. He would call attention to one specimen, having a colored border with an edging which had the appearance of ground glass. It was, however, produced by a coating of flux. The colored border was also added, and was burnt in at the same time with the white enamel, — all in one firing, — showing that a color and white enamel could be accomplished at the same time. He had been able to produce four colors in one burning. He had no doubt, with improved manipulation, a variety of colors could be produced at one firing; but all glass painters were aware that to attempt to produce perfect copies of pictures, with all shades of colors, would be to branch into another line of art. Instead of being mere printing, it would become regular glass painting. It had been his object to avoid that from the first. As regards price, he believed the pictures could be afforded for eight shillings (two dollars) per square foot.

Mr. Hawes said that the members of the society must have arrived at the conclusion, from what they had heard, that there was a new application of one of the newest and most recent discoveries connected with the art and industry of the present day. Photography, a young art, was applied in a new form, and with great facility, to produce most beautiful effects. They sometimes saw decorations of windows which, though beautiful within, had a very unsightly appearance from the outside; but here they had both sides equally beautiful. It was an invention of a peculiar kind. It was pure photography applied to glass, with this addition, that it was burnt into the substance of the glass, and became as durable and indestructible as the glass itself; and this he apprehended constituted one of the chief merits of the invention. It would enable them, he trusted, before long, to obtain copies of beautiful pictures for decorative purposes, at comparatively small cost.

SPECIFIC INFLUENCE OF THE COLORED RAYS OF LIGHT.

M. Baudrimont gives, as the result of his researches upon the chemical action of solar light, that, contrary to the opinion generally entertained, chemical rays exist throughout the whole extent of the solar spectrum. The facts observed also lead to the belief that each species of colored light possesses a special action, and that each may be completely inert with regard to certain matters, but, on the contrary, very energetic with respect to others. Another series of experiments enables M. Baudrimont to establish the influence of the various colors of the spectrum upon the development of vegetation. Thus, for instance, no colored light permits vegetables to go through all the phases of their evolutions; none of them have flowered or fructified. Violet-colored light is positively injurious to plants: they absolutely require white light.—*Paris Corr. of the Photographic News.*

PHYSICAL CONSIDERATIONS REGARDING THE POSSIBLE AGE OF THE SUN'S HEAT.

In a paper on the above subject, presented to the British Association (1861) by Prof. W. Thomson, the author prefaced his remarks by drawing attention to some principles previously established. It is a principle of irreversible action in nature, that, "although mechanical energy is indestructible, there is a universal tendency to its dissipation, which produces gradual augmentation and diffusion of heat, cessation of motion, and exhaustion of potential energy, through the material universe." The result of this would be a state of universal rest and death, if the universe were finite and left to obey existing laws. But as no limit is known to the extent of matter, science points rather to an endless progress through an endless space of action, involving the transformation of potential energy through palpable motion into heat, than to a single finite mechanism, running down like a clock and stopping forever. It is also impossible to conceive either the beginning or the continuance of life without a creating and overruling power. The author's object was to lay before the Section an application of these general views to the discovery of probable limits to the periods of time, *past* and *future*, during which the sun can be reckoned on as a source of heat and light. The subject was divided under two heads: 1. On the secular cooling of the sun; 2. On the origin and total amount of the sun's heat. We do not know certainly that the sun is losing any heat at all, and it is certain that *some* heat is generated in its atmosphere by the influx of meteoric matter, and it is possible that the amount thus generated is so balanced as to compensate the loss by radiation. It is also possible that the sun is now an incandescent liquid mass, radiating away heat either primitively created or thus generated by the falling in of meteoric matter. From astronomical considerations, he showed that none of this matter can come from space beyond the earth's orbit; and by considerations derived from the disturbances of the inferior planets and the zodiacal light, the author had shown that the amount of meteoric matter could not be nearly enough to give a supply at the present rate for 300,000

years; and these anticipations have been verified by the recent researches of Le Verrier on the motions of the planet Mercury. Then, from further considerations connected with the motion of comets, he shows that this meteoric matter must be derived from spaces very near to the sun. He then proceeds to estimate how much the sun cools annually, and concludes that it cannot be more than 1°.4 Centigrade annually. He then shows, from facts derived from various sources, chemical and astronomical, that the certain limits are entirely inconsistent with some of Darwin's geological estimates of time. Under the second head, the author shows that the statement which he first made still holds, with undiminished force, — that meteoric action is not only proved to exist as a cause of solar heat, but it is the only one of all conceivable causes which we know to exist from independent evidence. The reasons for this are again given at length. And he concludes it is, on the whole, most probable that the sun cannot have illuminated the earth for 100,000,000 years, and certain that it has not for 500,000,000; and as to the future, that the inhabitants of the earth cannot continue to enjoy the light and heat necessary for their existence for many million years longer, unless some sources now unknown to us are prepared in the great storehouse of creation by Him who orders all things rightly and well.

NEW PYROMETER.

Serious difficulties have hitherto presented themselves in the construction of a really exact pyrometer. M. Noble, an engineer at St. Petersburg, has long been engaged in the study of the heat developed by furnaces of various kinds. As the result of his experiments, he has recently brought out a very simple apparatus, most easy of application and exact in its indications. This apparatus consists essentially of a cylindrical vessel or chamber composed of platinum or other refractory substance, capable of withstanding a considerable degree of heat. This chamber is connected by a tube with a pressure-indicator or manometer. Bourden's is found to answer well. The vessel is placed in the furnace, and the tube is passed through a luted opening in the side thereof, and is connected at its outer end with the manometer. By using a very sensitive Bourden's manometer, and by adding thereto an apparatus for showing the number of revolutions of the needle or indicator, the increasing temperature for each degree will be readily arrived at, allowance being made, of course, for the atmospheric pressure on the apparatus itself.

THE PHENOMENON OF REGELATION.

In the year 1850, Prof. Faraday directed the attention of scientists to the remarkable fact that two pieces of moist ice, when placed in contact, will unite, even when the surrounding temperature is above 0° Cent. To the phenomenon in question the term "regelation" has been applied by Tyndall, who has made the fact above mentioned the basis of a theory of the plasticity of ice, in accounting for the descent of glaciers. Several theories have been advanced to explain the facts of regelation. Faraday explained it by assuming that a particle of

water can retain its fluid condition only when in contact with ice on one side, but freezes when touched by ice on both sides, the general temperature remaining the same. This explanation — with all deference be it said — is simply a re-statement of the fact, and not an assignment of a physical cause. Person maintains that the solution of ice is a *gradual* process, the ice passing through intermediate states of viscosity to the condition of a liquid. He considers ice as essentially colder than the water in contact with it; that a film of plastic ice or viscid water lies between the ice and the water, and that heat is constantly passing from the water to the ice through this film. The water therefore becomes colder and finally freezes. This view is adopted by Prof. J. D. Forbes. Neither Person nor Forbes explains why a thin film of water in contact with a mass of ice has or can have any other temperature than the ice itself, nor why water at 0° should give off heat to ice at 0°. Prof. James Thomson's theory is, in his own words, as follows: If to a mass of ice, at its melting point, pressures tending to change its form be applied, there will be a continual succession of pressures applied to particular parts — liquefaction occurring in these parts through the lowering of the melting-points by pressure — evolution of the cold (*sic*) by which the so melted portions had been held in the frozen state — dispersion of the water so produced in such directions as will afford relief to the pressure — and re-congelation by the cold previously evolved of the water on its being relieved from this pressure: the cycle of operations will then begin again; for the parts re-congealed, after having been melted, must in their turn, through the yielding of other parts, receive pressures from the applied forces, thereby to be again liquefied, and to proceed through successive operations as before. This theory certainly appears to be tenable in the case of glaciers, or wherever great pressures are applied, as in the moulding of ice under a hydrostatic press, but its application is, to say the least, doubtful in the case of simple contact between small masses of ice. Moreover, Faraday has shown that pressure is not necessary in regelation. Of the numerous experiments which he has instituted, the following appears to us the most convincing. Two round cakes of ice, convex upon the upper surfaces, are placed in water of ordinary temperature and then sunk beneath the surface by little weights of wax or spermaceti. Two such pieces of ice touching each other gently at a single point freeze together. In this case no sensible capillary action takes place in consequence of the figures of the masses of ice. Faraday did not succeed in obtaining regelation with melted bismuth, tin and lead, nor with glacial acetic acid, or saline bodies. He considers the phenomenon therefore as peculiar to water. — *Silliman's Journal.*

THE EXPANSION OF WATER NOT AN ANOMALY IN THE SOLIDIFICATION OF LIQUIDS.

In most works on physics, reference is made to the dilatation of water when cooled down to near the freezing point, and to the beneficent effect of ice being thus caused to float, instead of sinking and choking up our rivers. The fact is also mentioned as a remarkable exception to the general law of expansion of liquids in proportion as

they are heated. Thus, Arnott, in his Physics, designates it as "a most extraordinary exception to the law of expansion by heat and contraction by cold," producing unspeakable benefits in nature, etc.

In Brande's Dictionary of Science it is said, "In general, all liquids expand and contract in proportion as they are heated and cooled, but to this law there is a remarkable and anomalous exception in regard to water."

In Kemp's Phases of Matter, London, 1855, we are told, "There is a most remarkable exception to this law of expansion in the case of water. Ice, as every one knows, swims upon water, and of course is lighter, that is to say, heat does not expand ice, but, on the contrary, contracts it. Whatever may be the cause, it is one of the most striking instances of design that can be witnessed in nature, and were it not for it, the globe would be scarcely habitable by man. Did water obey the usual law in this respect, it would fall to the bottom as fast as formed."

Considering the progress of science down to the close of the eighteenth century and its still further advances to the present day, it is singular that this alleged anomaly should have been so long taken for granted and stereotyped in works on natural philosophy. It is many years since it was questioned by members of the Philadelphia Mechanics' Institute, because of its inconsistency with facts familiar to them. It was stated that it presented no "remarkable," "peculiar," "curious," "extraordinary," or "anomalous" exception, nor any exception at all to any law, but was in strict accordance with the one that governs the solidification of liquids — that if ice did not float, the fact would be an anomaly.

It was affirmed that, if our lakes and rivers were fluid metals, with their surfaces congealed in winter, the solid portions would swim as ice swims; and the proofs offered were that pigs of lead and tin float in liquid lead and tin, and that the like takes place with gold and silver, zinc, copper, and iron, as may be daily witnessed in the factories. The inference seemed to be that most, if not all, solids are less dense than are their liquids at certain temperatures, and those who doubted this were asked to name a liquid, either vegetable, animal, mineral, or metallic, in which portions solidified do not swim. Wax, pitch, rosin, fat, sugar, sulphur, and other substances, were named as affording no support of the common doctrine.

In passing into the solid state, the molecules of every liquid assume an arrangement more or less peculiar to it, and, as this must take effect at some point of the decreasing temperature, it matters not where that point is as respects the common law of expansion. It no more affects that law than the journey of a traveller is affected by his stopping a moment to exchange a word with a friend. It neither affects his previous nor his subsequent progress — has, in fact, nothing to do with either.

The temperature of solidification of course differs in different substances, and so does the effect. It is the molecular arrangement that diversifies the crystalline structures, and consequently the properties of solids; that gives to each a "grain" and character peculiar to itself. In the soft metals, the crystalline texture would hardly be suspected, but it may be vividly brought out, even in lead, by crushing a

mass just before solidification is completed. In iron foundries, the moment when the crystals are forming is often indicated by a rising of the metal in the gates of a mould.

It is known that the crystalline structure of metals is deranged by rolling, stamping, forging, wire-drawing, and other processes, but it is not commonly known that this effect is temporary, — that they have power within themselves to recover their pristine formation. This we have noticed in drawn wire and pipes of block tin. When of pure metal, they are soft almost as lead, and yield to flexure as silently; but if laid aside a few years, they give out when bent the crackling noise by which bars of the metal are characterized.

A very interesting fact is mentioned by Scoresby. He found in the Arctic regions that water congeals there in an almost endless variety of geometrical figures, of which he enumerates five classes — the lamellar, the stelliform (which is most general, and occurs chiefly when the temperature is near 32°), the regular hexagon (which becomes thin and diminishes in size as the cold increases), aggregates of hexagons (which occur chiefly at low temperatures), and, lastly, combinations of hexagons with spines or radii. — Arctic Regions, vol. i. p. 432. — *Phil. Journal Franklin Institute.*

GROUND ICE.

Ground ice is the ice found under the surface of the water in rivers. It has engaged the attention of men of science on account of its apparently unnatural position, and also the attention of practical men because of the mischief it may occasion by accidental obstructions, such as a branch of a tree in a mill-course, when the water is charged with icy particles. Mr. Richard Adie has published a paper in the *Journal of the Chemical Society* on this subject. He believes that he was the first to state that ground ice is formed in the coldest part of the stream, and that the small crystals, as soon as formed, are carried along by the current and submerged and entangled by plants, etc. In December and January, 1860–1, he searched for ground ice where he had previously found it; but, although the frost was severer than it had been for sixty years past, he found it only in one locality, viz., on a stone covered over by the water of a rivulet at Duddington, near Edinburgh. Other observations have led him to the opinion that the position of ground ice is one of lodgment merely, in opposition to the notion that the water has frozen in the bed of the river, the current preventing its freezing in its natural place — the surface. In a note on Mr. Adie's paper, the eminent chemist, Dr. E. Falkland, gives his opinion that the formation of ground ice, which takes place only in rapidly-flowing streams, depends upon the fact that ice, like other crystalline bodies, deposits itself more readily on rough surfaces (freezes, in fact, at a higher temperature) when in contact with such surfaces than within the mass of liquid itself. Hence when a rippling stream is cooled to 32° ice crystals attach themselves to the pebbles at the bed of the river and form nuclei for further deposition.

NATURAL ICE CAVES.

In a number of the *Bibliothèque Universelle de Genève*, Prof. Shuny has printed a memoir on these remarkable grottoes. The glacier La Baume, near Besancon, seems to have been the first to attract the attention of philosophers, which appears to be not only a great conservator, but also a great producer of ice. In 1727, when the camp was at the Saone, the Duc de Levi had the ice taken from the cave in a great many carts; yet, in 1743, the cave was re-supplied with ice, which covered the floors and walls, and was suspended as stalactites from the roof. As the mean temperature of the soil where the grotto exists is several degrees above the freezing point, a change must take place between the interior and the exterior, in which, for a time, the heat taken off must exceed that received. M. Shuny gives the theories of Prévost, Pictet, and others, and then, in a second part of his memoir, gives an account of his own excursions and investigations, especially in the glaciers of Jura, in 1857–61. He gives the following as the causes of the formation of ice: During the winter the heavy cold external air falls through the holes of the grotto, displaces the less cold air, and freezes the water in the grotto. In the warm season, the heavy cold air cannot be displaced, and transmits heat feebly, while the radiation of the walls and roof, and the heat of the soil, melt only a small quantity of ice, which absorbs much heat when passing to the liquid state. In addition, the branches of the trees which overshadow the openings of the cave, the exposure to the north, the vegetation which covers the soil, the incessant evaporation of the surface, attenuate as much as possible the effects of the solar heat, and maintain the cold of the upper part of the grotto. In January last M. Joret, with two companions, visited the ice cave of the Vergy, in the Alps. They passed the night at the Convent of the Chatreuse, in the middle of a long valley, a situation of severe beauty. Thence they descended by a steep road, a quarter of a league long, to the village Pralong du Reposoir, where they halted. The mountaineers affirmed that nothing could be found in the "grand cave" but water and vapor, but had not been there to see. The entry to the grotto was found to be free. The snow had slid down towards the bottom of the valley, where it formed a thick layer. Beautiful stalactites hung from the roof; perfect silence reigned; very dry ice appeared everywhere in the form of columns, slabs, inclined planes, etc. There was no water or snow anywhere, and the atmosphere was very still and cold.

THE PRODUCTION OF MIST AND HAIL.

The production of mist is the subject of a note by the veteran Dr. John Davy, in the *Edinburgh Philosophical Journal*. The cause usually assigned for mist is the access of cold air and its admixture with warmer air, saturated or nearly so with moisture, strikingly exemplified in our autumnal and winter fogs, when the water, owing to the heat absorbed during summer, is of higher temperature than the inflowing air. Dr. Davy, however, refers to another cause, not so much noticed, viz., a mild moist air coming in contact with a colder air, equally humid, resting on cold surfaces, whether of land or water,

about the end of winter or beginning of spring. He describes mists which he considers to have been thus formed in the lake district of Cumberland. To a similar cause, also, he refers the phenomenon termed sweating, which is the precipitation of moisture on walls and flagged floors excluded from the influence of fire. He also attributes to a warm south wind, succeeding a very cold north wind, the deposition of a large quantity of moisture which he once saw on the pictures in the gallery of a nobleman in Devonshire, and quotes the saying of Homer, —

"The south wind wraps the mountain-top in mist."

The Freezing of Water and Formation of Hail. — This subject has been investigated by Prof. Dafour, of Lausanne, who has published the following conclusions as the result of his researches: —

1st. When water is kept in suspension in a fluid medium, free from all contact, it seldom freezes at 32° Fah. The liquid state is preserved at 23° and 14° above zero, and even at 13° below zero, Fah. 2d. Solidification is produced under divers influences (contact of solids, etc.). 3d. Under suitable circumstances freezing may be provoked at a temperature lower than 32°, and solid spheres obtained analogous to hail. 4th. Hail is probably produced when the watery globules suspended in an agitated atmosphere are cooled down lower than 32°, the condensation and congelation of vapor on their surface contributing to increase their size. 5th. The principal characteristics of hailstones may be suitably explained in supposing their origin to have been that which has been indicated above.

THE FREEZING AND BOILING POINTS OF WATER.

M. L. Dufour has communicated to the French Academy the results of some interesting experiments showing that water and certain other substances may be maintained in the liquid condition at temperatures much beyond the point at which they usually pass into either the solid or vaporous state, by placing them in a fluid menstruum of the same density as themselves, and with which they are not miscible. Globules of water thus suspended in perfect equilibrium retain the fluid condition through a much longer range of temperature than is possible under other circumstances.

The boiling point of liquids is known to vary considerably, and to be particularly affected by the nature of the vessel in which the liquid is contained. With water the boiling point is higher in a glass than in a metallic vessel. When the surface of the glass has been specially cleansed with oil of vitriol the discrepancy becomes still more marked. When placed under the conditions of a water hammer, in which it is entirely free from air, and contained in a glass tube, Donné has shown that it may, by careful heating, be raised to 135° Cent. without passing into the vaporous condition. The deviation in such cases is attributed to the force of adhesion existing between the liquid and the surface of the vessel, and the absence of air from solution.

In M. Dufour's experiments, however, the result cannot be attributed to the absence of air, or to the adhesion of the liquid to a solid; on

the contrary, contact with a solid produces an instant gush of vapor. His first experiment is as follows: — Some linseed oil is heated in a dish to 105° Cent. or 110° Cent., and a few drops of water dropped in, which sink to the bottom of the vessel. The moment they touch, a sudden formation of vapor takes place, and the globule, a little lessened, is repelled a short distance from the bottom. It again sinks till it touches, when it again boils, and is again repelled. While the globule is floating through the oil no evaporation takes place; it is only on coming into contact with the solid that vapor is formed.

M. Dufour's next experiment consists in using a medium having the same density as water, and in which, consequently, the globules remain in equilibrium, permanently floating in the centre; the medium being capable of bearing a temperature above 100°, and not being miscible with water. Essence of cloves, to which a small quantity of oil has been added, constitutes a fluid answering to these conditions. Water remains floating in round spheres with perfect freedom of motion in the centre of this mixture. Under these circumstances, if heat be carefully applied, a temperature far above 100° Cent. may be obtained without the ebullition of the water ensuing. 120° or 130° Cent. is frequently reached, and spheres of water ten millimetres in diameter have been thus raised to 140° and 150° without changing. Smaller spheres, one to two millims. in diameter, have been raised to 170° and even 175° Cent.: that is to say, a temperature at which steam has a tension equal to eight atmospheres (or one hundred and twelve pounds). The water used had not been prepared; it was neither distilled nor freed from air. At these high temperatures the globules were as calm and transparent as at 10°. When the globules came into contact with a solid, then ebullition instantly ensued. If carried against the side of the vessel or against the bulb of the thermometer, a sudden formation of vapor was the result, and the globule was repelled some distance from the point. By touching the globule when at 115° or 120° with a glass or metal rod, or, better, a point of wool or charcoal, a similar effect was produced; an explosive formation of steam taking place, and the globule being driven away as if the point had exerted some repulsive force.

These phenomena may also be produced with other liquids treated under the same conditions. Chloroform may be so heated when floating in a solution of cloride of zinc to a temperature of 90° or 100° Cent.

By means similar to the above, M. Dufour has equally succeeded in retarding the freezing of water. A mixture of chloroform and oil of sweet almonds is made, in which globules of water float in equilibrium. By cooling the mixture, the water scarcely ever freezes at 0° Cent. Its temperature sinks to — 6°,— 10° before congelation occurs, and globules have even been reduced to — 20° Cent. without solidifying. Ultimately the globules either pass into solid grains of ice, or simply freeze on the surface, depending on the size and amount of reduction in temperature. The persistence with which the water retains the liquid state, is, however, remarkable. The mixture containing the globules may be shaken, and foreign bodies introduced, without solidification resulting. By touching the sphere, however, with a lump of ice, congelation is immediately effected. When one

globule solidifies, the congelation of others still fluid may be effected by bringing them in contact with the frozen particle. Different effects are thus produced, depending on the temperature and the size of the spheres. Sometimes the spheres touching solidify suddenly, but remain separate; sometimes they combine together, the one joining on or else enveloping the other at the moment of congelation. Irregular spheres formed of concentric layers and other varied shapes are thus produced. The author traces a resemblance between these frozen particles and the shape and structure of hailstones, which he conceives may be formed by a process somewhat analogous.

Other substances besides water present the foregoing phenomenon. Thus M. Dufour has experimented with sulphur, phosphorus, and naphthaline. He finds that when melted sulphur is suspended in a solution of chloride of zinc having the same density as itself, the temperature may be reduced to 70° or 50° without solidification taking place. In this instance, the liquid condition possesses remarkable stability. When the globules of sulphur remain fluid at 50° or 60° below the usual temperature of solidification, their change of state constitutes an interesting object. Globules half a millim. in diameter sometimes remain liquid at 5° Cent. for several days. Solidification is best provoked by contact with a piece of sulphur. Phosphorus in like manner may be reduced far below 44° Cent. without solidifying, and small globules may even be reduced to 5° or 6°. Many other substances would doubtless present the above phenomena. The principal obstacle lies in the difficulty of finding suitable menstrua.

Additional Experiments on the Boiling Points of Solutions. — The boiling point of water is raised by the addition of a soluble salt, or by the addition of a strong acid, and this augmentation of the boiling temperature depends upon the relative amount of salt or acid added as the case may be; but hitherto no general formulæ have been given to express the relation between the augmentation of boiling temperature and the relative weight of the substance added to the water. Mr. T. Tate has performed a series of experiments, with the view of obtaining some laws on the subject; and states that he has found, for certain chlorides, nitrates, and carbonates, that the augmentation of boiling temperature may be approximately expressed in a certain power of the percentage of the salt dissolved.

RADIATION AND ABSORPTION OF HEAT AND LUNAR RADIATION.

In a recent letter to Sir John Herschel, in reference to the researches of the latter on solar radiation, Prof. Tyndall states that he has been for some time experimenting on the permeability of our atmosphere to radiant heat, and that he arrives at the conclusion that true air, *i. e.*, the mixture of oxygen and nitrogen which forms the body of our atmosphere, is, as regards the transmission of heat, a practical vacuum. The results from which the opacity of the air have been inferred are all to be ascribed to diffused extraneous matters, and mainly to aqueous vapors. On Oct. 10, last, he found the absorptive action of the common air in the laboratory of the Royal Institution, London, to be made up of three components, — the first

due to the pure air being represented in magnitude by No. 1; the second due to the transparent aqueous vapor by No. 40; and the third due to the effluvia of the locality, and the carbonic acid of the air by No. 27. The total action of its foreign constituents was certainly sixty-seven times that of the atmosphere itself, while the aqueous vapor alone exerted an action at least forty times that of the air. On Oct. 18, Prof. Tyndall made a series of observations on the moon from the roof of the Royal Institution. From six concurrent experiments, he says: "I was compelled to infer that my thermo-electric pile lost more heat when presented to the moon than when turned to any other portions of the heavens of the same altitude. The effect was equivalent to a radiation of cold from our satellite. I was quite unprepared for this result, which, however, you will at once perceive may be an immediate consequence of the moon's heat. On the evening in question a faint halo which surrounded the moon, and which was only visible when sought for, showed that a small quantity of precipitated vapor was afloat in the atmosphere. Such precipitated particles, in virtue of their multitudinous reflections, constitute a powerful screen to intercept the terrestrial rays; and any agency that removes them and establishes the optical continuity of the atmosphere must assist the transmission of terrestrial heat. I think it may be affirmed that no sensible quantity of the obscure heat of the moon, which, when she is full, probably constitutes a large proportion of the total heat emitted in the direction of the earth, reaches us. The heat is entirely absorbed in our atmosphere, and on the evening in question it was in part applied to evaporate the precipitated particles, hence to augment the transparency of the air round the moon, and thus to open a door in that direction for the escape of heat from the face of my pile. The instrument was furnished with a conical reflector, the angular area of which was very many times that of the moon itself."

CONDUCTION OF HEAT BY GASES. — BY G. MAGNUS.

The cooling of a body *in vacuo* depends simply on the exchange of heat by radiation between the cooling mass and the encircling envelope. If the space contains gas, an ascending current is formed, which accelerates the cooling, added to which the property which the gas has of transmitting heat, or its diathermancy, concurs in producing cooling, provided the gases can conduct heat. Dulong and Petit, in enunciating their law of the loss of heat, have neglected the last two actions, manifestly because they are infinitely small compared with the influence of the ascending currents. Since then, it has been universally admitted that the differences in the cooling of the different gases depend on the different mobility of their particles. Cooling takes place much more rapidly in hydrogen than in other gases. With the same amount of heat, this gas expands not more, but less, than atmospheric air; the changes in density in the former gas are less than the latter. But it is the difference of specific gravity which produces currents. If, therefore, different gases by contact with a warmer body all become equally heated, the currents in those gases which have a greater co-efficient of expansion must be greater than in

the rest; for example, in carbonic acid more than in hydrogen. As this is not the case, it must either be assumed that the friction of the gaseous particles against each other is so great that the influence of the greater expansion is neutralized by it, which will with difficulty be admitted, or it must be assumed that gases by contact with a hot body become heated to a different extent. Such a difference in the degree of heat would take place if the gases had different capacities for heat; but as the specific heats of hydrogen and atmospheric air are the same, there remains no other explanation for the more rapid cooling in hydrogen, than that this gas can transmit heat from particle to particle, in other words, can conduct it, and that it possesses this property in a higher degree than other gases. Its low density appeared to be in disaccordance with this idea, and it appeared necessary to decide by experiments how far it is founded.

The impulse to these experiments was given by a repetition of Mr. Grove's interesting observation, according to which a platinum wire is less strongly heated when surrounded by hydrogen than by atmospheric air, or another gas. In this repetition it was found that hydrogen exerted its preventive action even when a layer only 0.5 mil. thick surrounded the wire, and it was the same whether the tube containing it was in a horizontal or vertical position. In such a narrow tube, especially when it is horizontal, currents can scarcely occur; and when there are none, there remains no other explanation than that hydrogen conducts heat better than other bodies.

The simplest mode of ascertaining whether a gas conducts heat consists in warming it from above, and observing the action on a thermometer placed within. It might be objected to this method that, even with heating from above, currents in the gas might be formed, and that thereby the temperature indicated by the thermometer in various gases might be different without any difference in conductibility.

There is one method of testing this objection; for if, in fact, a gas can conduct heat, the temperature assumed by a thermometer in a space heated from above must be lower when the conducting substance is wanting than when it is present; that is, it must be lower *in vacuo* than in a space filled with air.

In order to ascertain whether this was the case, a glass apparatus was used, in which a thermometer, observable from without, was firmly fixed. It could be filled with different gases, and these could be variously dilated. The upper part of this apparatus was maintained at the same temperature, namely, that of boiling water, and the temperature was observed which a thermometer introduced into the interior ultimately assumed. Of course the experiments with this apparatus were not made without numerous precautions; it was more particularly necessary that the whole apparatus should be always under the same conditions, so as to give off the heat imparted to it always in the same manner. For this it was necessary that the space surrounding it should always be at the same temperature. In these experiments, the temperature of the surrounding space was 15°.

In this way the following results were obtained: — 1. The temperature which a thermometer ultimately assumes in a space heated from above differs when this space is filled with different gases. 2. In hy-

drogen the temperature is higher than in any other gas. 3. In this gas the temperature is higher than *in vacuo;* and the denser the gas is, the higher is the temperature. 4. Hence, hydrogen conducts heat like metals. 5. In all other gases the temperature is lower than *in vacuo;* and the denser they are, the lower is the temperature. 6. It cannot hence be concluded that gases do not conduct heat, but only that they do this in so small a degree that the action of conduction is cancelled by their diathermancy. 7. This remarkable property of hydrogen is evinced not only when it moves freely, but also when it is contained between eider down, or any loose substance which hinders its motion. 8. The great conductibility of this gas is a further confirmation of its analogy with metals. 9. Hydrogen conducts not only heat, but also electricity, better than other gases.

COMBUSTION IN RARIFIED AIR.

Dr. E. Frankland, in a recent paper on the above subject before the Royal Institution, stated that in the autumn of 1859 he burnt candles protected from draught on the summit of Mont Blanc and at Chamounix, with the view of determining the effect of various degrees of atmospheric pressure on the amount of combustible matter consumed. He found, as the average of five experiments, that a stearine candle diminished in weight 9.4 grammes, when burned for one hour at Chamounix, and 9.2 grammes when ignited for the same length of time upon Mont Blanc. These experiments went to prove that the ratio of combustion was almost independent of the density of the atmosphere, as the pressure at the two places varied several inches in the barometer. But when burning the candle on the top of the mountain it was noticed that the flame was not so brilliant as in a more dense atmosphere. These results induced him on his return to England to make experiments with a coal-gas flame burning in a glass jar under different pressures of the atmosphere, produced by artificial arrangements. He passed the gas through a governor valve, secured a uniform flow in the burner, and the experimental flame was placed at one extremity of a Bunsen's photometer. Near this flame was placed a similar jet surrounded with a glass shade, but it was permitted to burn freely in the air so as to compare it with the other flame that was subject to variations of atmospheric pressure. From data gained in this way, Prof. Frankland was led to the conclusion that the rarefaction of air, from atmospheric pressure downwards, produces a uniformly diminishing illuminating power until the pressure is reduced to about 14 ins. of mercury, below which the diminution of light proceeds at a less rapid rate. Thus, an amount of gas which would give a light equal to 100 candles when the barometer stands at 31 ins., would give a light equal to only 84.4 candles if the barometer fell to 28 ins. The question, however, which Professor Frankland found the most difficulty in solving was, the decrease of luminosity of the flame with the decreased pressure of air, while the combustion of the gas was about the same in quantity in both cases. His final conclusion was that this anomaly was due to the circumstance of a greater quantity of air finding access to the interior of the flame.

MUSICAL ACOUSTICS.

Prof. Helmholtz, in a recent lecture before the Royal Institution on Musical Acoustics, by means of Prof. Wheatstone's wave apparatus, illustrated his views of the simple aërial waves which produce simple and compound musical sounds, and also explained and illustrated what are called harmonics. If a musical note be produced from a bell, an open string, or from almost every instrument, a practised ear can detect, in addition to its proper note (say C), its octave, 12th, etc. Every tone thus contains its own harmony. To facilitate the preception of these harmonies, the Professor had arranged a series of eight tuning-forks, each fastened to the ends of horse-shoe electric-magnets and joined to resonant glass tubes tuned to a precise note of the fork. The mouths of the tubes were provided with movable covers, which might be removed by means of threads, whose ends were fastened to a set of piano-forte keys. The tuning-forks were made to vibrate by means of intermittent electric currents, and the intensity of each note could be regulated by opening the tube more or less completely. By means of this apparatus many interesting points connected with the subject were illustrated, and by combining the various sounds the Professor succeeded in producing a remarkable imitation of the vowel sounds (u, o, ah, a, e, etc.) The lecture was concluded with remarks on the physiology of the subject and on its psychology, *i. e.*, the effect which musical combinations of sound have on the soul.

PHONAUTOGRAPHY.

For several years past a French physicist, M. Scott, has been engaged in experiments on the fixation of sound upon a prepared tablet, in the same way as photography fixes luminous images; and has met with considerable success in this new art, which he has named Phonautography. At a recent meeting of the French Academy a short communication was made by the discoverer, in consequence of the publication of some experiments in the same direction made by other gentlemen. This communication was devoted chiefly to a description of certain illustrations laid before the members, and would be unintelligible to the general reader without the diagrams. The subject, however, being of immense importance, and likely now to attract great attention, a short account of what has already been done by M. Scott will perhaps be considered of interest.

The problem which first required solution was the artificial construction of an ear, by means of tubes and diaphragms, so as to imitate, as nearly as possible, the human ear in its power of collecting sounds of every degree of intensity, and transmitting them to a delicate membrane placed at the extremity. After numerous essays, an apparatus was constructed which possessed the above qualifications; the membrane was seen to vibrate visibly, and in a different manner, with each audible sound or note; and if a pen or style were fastened to this membrane, its point would trace the wonderfully beautiful and complicated curves and circles appertaining to the elements of sound. The next difficulty consisted in finding a sensitive surface upon which this style could mark the imprint of its movements; for the vibra-

tions of the aërial pen were so delicate that if any appreciable force were required to effect the transcription, the resistance would at once stop all movement. This difficulty was at last overcome by employing a strip of thin paper, upon which was deposited a film of lampblack obtained from the smoke of burning bodies. This sensitive surface is carried along by clockwork agency, in front of the vibrating style, so that the successive movements of the latter shall not impinge one on the other, when the result is a series of lines written on the paper, composed of the most complicated systems of curves, and forming a natural autograph of the producing sounds.

Of course it will be understood that the above is intended more as a brief outline of the principle of M. Scott's instrument than as an exact description of its individual details. In reality, especially in the one recently made, it is far more complicated than would be imagined from this brief sketch; but the phonographs produced by it are marvellously perfect. Every separate source of sound has an individuality of its own. The sounds of different musical instruments, for instance, are easily distinguished from one another, and from the human voice. This latter, moreover, gives different traces, according to its character — the sweet, soft voice of a female, especially when singing, being characterized by great beauty and harmony in the curves impressed on the paper; in those produced by the harsher voice of a man, the curves are larger and more rugged-looking; whilst in a shriek or a shout, or in the harsh, discordant sounds of instruments, the waves are irregular, unequal, and broken up into secondary vibrations of all degrees of amplitude.

An oration, delivered with varying rapidity, and with the pitch of the voice greatly modulated in different parts, has a very striking appearance in its phonograph. Rapidly-spoken parts have the curves crowded together, whilst in others they are widely separated. The loud tones of the voice are shown by the written waves rising to perhaps half an inch or more in height, whilst the low tones are not more than the eighth of an inch high. The modulations of the voice are thus shown very beautifully by the varying height of what may be called the letters of sound.

The fact of being able to make spoken sounds record themselves permanently on paper is of itself most singular and astonishing; but if it is ever developed, as the inventor says it shortly will be, to sufficient perfection to enable it to take down speeches, which may be written off verbatim, it is difficult to imagine the importance of the discovery, whether it be in respect to the unimpeachable accuracy of the process, the entire absence of trouble and expense in reporting any articulate sounds, or the great saving of the time and the exhausting labors of reporters.

ACOUSTICS IN BUILDING.

In a paper on the above subject read before the Institute of British Architects, by Mr. T. R. Smith, the author, after referring to the experiments of M. Biot on the transmission of sound through a pipe one thousand yards long, through which a whisper was distinctly audible, and to the curious exception discovered by Mr. Scott Russell to the

ordinary law of reflection of sound when the sonorous vibrations strike against a reflecting surface at an acute angle — maintained that in order to combine reflection and resonance in the construction of a building, there should be an inclined surface above the head of the speaker, to reflect the sound down upon the audience; the walls should be covered with wood, and there should be a space above the ceiling and under the floor. But in thus assisting the transmission of sound, great care should be taken to prevent echoes. To avoid echoes by reflection, the head of the speaker should be near the ceiling, or a sounding-board should be placed above him, so that the sound may be propelled onward; and the surface of the walls should be broken by pillars or draperies, particularly at the end. The vibrations caused by resonance should also be prevented by draperies, or by breaking up the surface by projections. Mr. Smith considered a short parallelogram, with a semi-circular end, as the form best adapted for hearing; the speaker being advanced to a forward position among the audience. The most difficult of all buildings for hearing a speaker, he said, are parallelograms of four flat sides, and with a high flat ceiling. Mr. Scott Russell strongly enforced the necessity of breaking up the surface to prevent reverberation; and, alluding to the different effects of the transmission of sound in full and in empty rooms, he observed that the best possible means of making sounds distinctly audible in large rooms is to cover the walls with beadings or mouldings.

VISION AND SOUND.

Prof. Stokes, in a note to a paper in the *Philosophical Magazine*, No. 126, observes: — The remarkable phenomenon discovered by Foucault, and rediscovered and extended by Kirchhoff, that a body may be at the same time a source of light, giving out rays of a definite refrangibility, and an absorbing medium, extinguishing rays of that same refrangibility which traverse it, seems readily to admit of a dynamical illustration borrowed from sound.

We know that a stretched string which, on being struck, gives out a certain note (suppose its fundamental note), is capable of being thrown into the same state of vibration by aërial vibrations corresponding to the same note. Suppose, now, a portion of space to contain a great number of such stretched strings, forming thus the analogue of a "medium." It is evident that such a medium, on being agitated, would give out the note above mentioned; while, on the other hand, if that note were sounded in air at a distance, the incident vibrations would throw the strings into vibration, and consequently would themselves be gradually extinguished, since otherwise there would be a creation of *vis viva*. The optical application of this illustration is too obvious to need comment.

DANIELL'S GREAT WATER BAROMETER.

A water barometer which had been constructed thirty years ago by Prof. Daniell, in London, was lately removed and put up in the Crystal Palace at Sydenham. About a foot and a half of glass having been broken off the lower end of the barometer tube, Mr. Negretti

succeeded in dexterously joining on a piece of glass tube to the broken end. The tube in question is about thirty-four feet long, and it was filled with water from which every particle of air had been driven by a jet of steam from a boiler. The steam was permitted to pass into the tube, which had its lower part situated in a vessel filled with distilled water, and upon a vacuum being formed in the tube, and its top hermetically sealed, the water ascended in it to a height of thirty-two feet nine inches. This is equivalent to a column of 28.84 inches of mercury. As a change in the atmospheric pressure which causes a variation of an inch in a column of mercury will cause a variation of more than a foot in a column of water, so the changes in the latter will be more than twelve times as great as in the former; and many oscillations of the atmospheric pressure, which otherwise would escape observation, will be noticeable. In gales of wind and heavy storms, the water inside of the long tube of Daniell's barometer trembles, and sometimes moves rapidly up and down as if animated by a spirit.

NEW PLUVIOMETER (RAIN-GAUGE.)

Common pluviometers consist of a square funnel fixed on the top of a roof, its narrow end being provided with a stopcock, and communicating with the interior of an apartment. The mouth of the funnel is generally a square foot, or some other square measure, in size; once a day the stopcock is opened, and the water in the pipe measured in pints, quarts, etc. We thus learn how much rain has fallen on a square foot, or other measure, within the lapse of twenty-four hours; but this is all — we know nothing of the duration of each shower, the size of the drops, their number, etc. To supply this deficiency, M. Herné Mangon, of Paris, has invented a new pluviometer, which he calls a *pluvioscope*.

Suppose a long strip of paper to be rolled on a cylinder, and then gradually unrolled by means of clockwork, so that in the course of twenty-four hours every part of it may have been exposed to the open air. It is evident that the length of paper unrolled will be proportional to the length of time elapsed; so that every hour and minute may be marked upon the paper. Now if the latter be so prepared as to receive the impression of a drop of rain, it is clear that its size and the precise moment of its falling may be ascertained. M. Herné Mangon prepares his paper with a solution of sulphate of iron, and then, after it has become dry, rubbing it with finely powdered galls. A drop of rain falling on paper thus prepared leaves a well-defined black spot, which will reveal all the circumstances of the shower. If, for instance, the spots are small and few, the shower has been a mere sprinkle; if small and numerous, a quiet but rather obstinate shower; if large, and many of them run into one another, the shower has been a violent one. By this contrivance, M. Herné Mangon has ascertained the number of showers that fell within given dates, and even the number of drops that fell, on a given spot, during some of these showers. For instance, he ascertained that on the 26th of last June, at half past eleven, A. M., the number of drops which fell, per hectare (a space of about two and a half English acres), in one minute, was one thousand eight hundred and twenty-six millions, the drops being

extremely small; whereas, on the 28th instant, at three-quarters past eleven A. M., in a heavy shower, only ninety-four millions of drops fell per hectare in the course of a minute, the drops then being very large.

THE COHESION FIGURES OF LIQUIDS.

This is a term applied by Mr. Charles Tomlinson, in the *Philosophical Magazine*, to the beautifully varied figures formed on the surface of water, mercury, etc., by oil of lavender, creosote, or other liquids dropped thereon. When one liquid is added to another and solution takes place between them, there is always a breaking up of the cohesion of one or other liquid; where there is no solution there may be simply adhesion. In both cases one liquid exhibits the characteristic phenomena of cohesion. The essential oils are but slightly soluble in water. If we place a drop of oil of lavender on the surface of the water, the adhesion of the water will cause it to spread out into a film; but the cohesion of the oil immediately begins to reassert itself, the film opens in a number of places, forming long irregular arms of processes resembling the pattern assumed by wood when it has been much worm-eaten. These processes tend to gather up into separate disks or tentacules; the adhesion of the water spreads them out; the cohesion of the oil struggles to prevent this, and soon prevails; the almost immediate issue being the formation of the original drop into a number of disks with sharp, well defined outlines and convex surfaces. The action often is so rapid and the pattern so complicated, that it requires repeated observation to become master of all the phenomena which are represented in a plate. Mr. Tomlinson considers this to be the resultant of the cohesive force of the substance, its density, and the adhesion of the surface on which it is placed, and believes that every independent liquid has its own cohesion figure. He gives a detailed account of his experiments with creosote, carbolic acid, ether, oil of cloves, olive oil, etc. He also suggests a mode of applying these cohesion figures in detecting adulterations. Chemically pure water should be used as the recipient. If mercury be substituted new figures are obtained from the same liquid.

THE BATHOMETER.

At the last meeting of the British Association, 1861, Mr. C. W. Siemens described an instrument, under the above name, designed to indicate the depth of the sea without submerging a line. The sea-water being considerably less in density than the rocks which constitute the crust of the earth, Mr. Siemens showed, by considerations derived from the integrals expressing the attractive force of any shell of the crust of the earth, that the depth of water under a ship must vary the total attractive force of the earth to such an amount as would become sensible to a very sensitive instrument. He, therefore, devised one, consisting of a body of air inclosed in a strong glass cylinder, made to support, by its elasticity, a column of mercury contained in a tube open at the bottom and dipping into it, kept at a uniform temperature by being surrounded by melting ice. The tube containing the mercury ends in a ball above, from which rises another tube and ball, the

upper ball being still continued into a similar tube. Above the mercury, which rises to the middle of the lower ball, oil of juniper is put until it reaches the middle of the upper ball, and then colored weak spirit is placed above the oil. The length of the column of mercury may be considered as a measure of the total gravitation of the earth, and the variations of this length are rendered very sensible by the differential apparatus, consisting of the two balls, and read off on a scale of about three inches length attached to the tube rising from the upper ball. The instrument hangs in the cabin of the ship. Government were kind enough to send a vessel with the author and the instrument to the Bay of Biscay to make experiments with it, and its indications of the depth of water under the ship were found to be within less than ten per cent. from the truth as determined by the lead.

MOVEMENT OF SEA AND LAKE WATER.

The fact that the movement of sea and lake water is confined to the surface is proved by the circumstance, that while the inclination of sand (where the bottom, near the shore, is composed of that material) may be seven horizontal to one perpendicular within the range of the tides and waves, it often stands at only two to one a short distance below, or at the natural slope of sand in still water. This is the case on the shore of the Lake of Geneva, near Vevay; and a similar result was observed at Cherbourg, with respect to the small materials thrown into the sea for the formation of the breakwater, and which took a slope, below low water, of one to one.

THE GYRATORY MOVEMENT OF A LIQUID MASS.

We translate the following from the *Presse Scientifique des Deux Mondes:* —

M. Perrot presented to the French Academy, in the month of October, 1859, a note, in which he expressed the opinion that the gyratory movement which manifests itself in a liquid mass, while it is running out through a small circular orifice in the horizontal bottom of a cylindrical vase, is an immediate effect of the diurnal movement of the earth. M. Magnus, on the contrary, had attributed the gyratory movement to the perturbation occasioned by a material obstacle or an exterior movement in the convergence of the liquid molecules toward a common centre. M. F. Laroque has just reëxamined the question, and numerous experiments, made on a zinc cylindrical vase of larger dimensions than those employed by M. Magnus, have led to the following conclusions: —

First. If there exist near the orifice any obstacles which modify the rectilinear convergence of the molecules toward the orifice in diametral planes, there may result a gyratory movement which changes sensibly the physical constitution of the liquid vein. But this movement propagates itself only to a very short distance from the orifice, and never rises gradually to the surface whenever the liquid is more than about four inches in depth; nor in any case does it communicate itself to the liquid mass.

Second. During the discharge the liquid molecules do not move from the circumference toward the centre — they fall.

Third. In the experiments of M. Magnus and M. Perrot, where they have observed a movement of rotation of the liquid mass, at first sensible at the surface above the orifice, and an instant after the discharge had commenced, this movement had existed before the discharge.

Fourth. The gyratory movement of a liquid mass, during the discharge, observed by M. Perrot, was not an immediate effect of the diurnal movement of the earth.

Discussing afterward an opinion given by M. Babinet at the time of the first experiments, that all the rivers of the northern hemisphere have a tendency to the right side, as an effect of the movement of the earth, M. Laroque arrives at this conclusion: that, "in the actual state of science, the flow of liquids cannot render manifest, in any case, the rotary movement of the earth." — *Scientific American.*

HYDRAULIC POWER.

A wonderful example, says the *London Mechanics' Magazine*, Sept., 1861, of what hydraulic pressure acting through suitable machinery can effect, is seen on the application of what is known as Armstrong's hydraulic apparatus at the Swansea docks. The pipes which convey the water, at a pressure of seven hundred pounds to the square inch, extend a mile and a half; the hydraulic power being available at any point throughout this length. By this agency, rendered so docile as to be almost within the control of a child, though before it the strength of the elephant sinks into insignificance, the gates are opened, the bridges swung, the sluices worked, and all the herculean labors of the docks performed. Man, no longer a mere drudge, exhausting his puny strength in endeavoring to counteract the forces of nature, employs these forces one against the other, and renders them obedient to his will. Mechanical science first taught how power might be gained at the expense of speed: the steam engine and the hydraulic press were an advance beyond this point of compromise, placing unconditionally in the hands of man a power which can scarcely be calculated as a multiple of a man's work in foot-pounds.

The only important practical objection to the universal employment of the stupendous power of hydraulic pressure wherever it may be made available, is the danger arising from the necessary steam apparatus erected in the vicinity of warehouses, in consequence of which increased rates of insurance become chargeable. To remedy this objection, it has been proposed to establish central stations for the generation of hydraulic power, and to distribute this by means of mains laid along the principal thoroughfares in proximity to wharves and warehouses, to which the power required for working cranes and hoists, or for any other purpose, would be conveyed by branch pipes. Thus a motive-power of any amount, certain in application, and under perfect control, would become available, with the advantage, in point of safety and economy, of dispensing with separate steam power for each establishment.

The full importance of the results which would follow the applica-

tion of this system are but partially shown in an arithmetical statement giving the mere pecuniary *saving* in actual hoisting. The speed with which the work can be done, and ships or barges loaded or cleared to make room for others, is a most important element in the calculations of the owners of wharf properties. Under the present system of manual labor applied to cranes and hoists, lifting forty tons through forty feet in twelve hours, by the employment of six men, must be considered a good day's work for the latter. The cost per ton in this case would be between six and seven pence; whereas, by hydraulic power, two hundred tons could be raised to the same height, in the same time, at a cost of about one and eight-tenths of a penny per ton.

The simple arithmetical statement shows that the cost of the present system varies from one halfpenny per ton per foot, for a "short lift," to one-sixth of a penny for a "high lift;" this being the actual cost of labor, without taking into calculation the interest of capital vested in machinery. By the application of hydraulic power under the proposed system, the cost of raising one ton one foot high is reinduced to about one-sixteenth of a penny; allowance being made, *at the rate of twenty-five per cent.*, for the interest of the capital necessary to establish the mains and the entire working machinery. At the Liverpool docks, the comparative expenses of the two systems have been calculated by Mr. Hartley, as bearing the proportion of eight to twenty-two in favor of hydraulic power.

RESISTANCE OF CAST-IRON TO PRESSURE.

The following statements are derived from a paper on the above subject, recently read by Mr. John Briggs before the English Association of Foremen Engineers.

There is a limit to the pressure which should be put internally to cast-iron, and there is a limit also to the *thickness* of metal to be used for cylinders of hydraulic presses. Such a statement might, at the first blush, appear to be irrational. The general opinion is that the thicker the iron the greater its resistance to pressure when the bore remained the same size. This he believed not to be the case, and Mr. Joseph Bramah had long ago the same opinion. At the time that one of the press cylinders employed in raising the tubes of the Britannia Bridge had burst asunder, a workman, once in the employment of Messrs. Bramah, thus wrote to the *Mechanics' Magazine* (Sept. 29th, 1849): — "At Bramah's we never found presses in constant work stand more than three tons (6,720 lbs.) on the square inch, and the greatest pains were taken to obtain the most approved kinds of iron — mixed qualities — to cast cylinders from. I have seen press cylinders stand 7,000 lbs. and even 8,000 lbs. on the square inch under proof for a short time; but we never could trust them to work with so much, and cast-iron then was far superior to that of the present day. Increasing the thickness of the metal in press cylinders was seldom successful. I have known metal seven inches thick stand as well as that of ten and one-half inches, for presses with rams ten inches diameter. The thicker the metal, the greater appeared to be the difficulty in getting it equal and homogeneous throughout."

The experience of Mr. Briggs was of a similar character. He considered that many cast-iron cylinders were cast too thick, under the supposition that they were strong in proportion to their thickness. There is a limit to the strength of all cast-iron cylinders, as it relates to their thickness, and efforts should be made to obtain thinner castings, as they were more uniform in strength, more dense, and better calculated to sustain pressure.

The general conclusions arrived at by Mr. Briggs were as follows: Three tons per circular inch he considered to be the bursting pressure of press cylinders. The maximum thickness of metal, when all due care had been exercised in its composition, should not be more than the radius of the bore of the cylinder. Two tons per circular inch was a safe pressure to work up to, and this he should pronounce to be his own standard.

LUNAR TIDES ON THE AMERICAN LAKES.

ERRATA.

We have received from Col. Graham, U. S. A., the following errata, in the paper entitled " Existence of a Lunar Tidal Wave on the great American Lakes," communicated by him to the *Annual of Scientific Discovery* for 1861, pp. 167–171: —

Page 169. In Table 1, opposite 1 hour 30 minutes before the moon's meridian passage, the " elevation of the lake surface in decimals of a foot," given in the second column, should be 0.098, in lieu of 0.089. This ordinate is derived from 1263.773 divided by 340, which gives 3.71697, or, for the nearest decimals of three places, 3.717, from which we deduct 3.619, and get the ordinate, 0.098.

Page 170, 16th line from top, for " six semi-diurnal tides," read " three semi-diurnal tides."

Page 171, 9th and 10th lines from the top, for " equal to 3.408 inches," read " equal to 3.048 inches." Same page, 12th and 13th lines from top, for " the established mean for the port of Chicago," read " the *Establishment* for the port of Chicago."

CHEMICAL SCIENCE.

CHEMICAL SYNTHESIS.

The Paris correspondent of *Silliman's Journal* (see No. 92, March, 1861) makes the following interesting statements on the future of Synthetic Chemistry, or the prospective manufacture of organic substances by the aid of chemical forces only. He says: —

The most remarkable scientific event of modern times is the publication of a treatise on chemistry, proceeding on the same plan in organic chemistry as has been adopted for a century past in mineral chemistry; that is, forming organic substances synthetically by combining their elements by the aid of chemical forces only. The author who has performed demonstrations by this method is Berthelot, who has been occupied with organic synthesis since he first devoted himself to chemistry. Berthelot is not a vitalist; he is convinced that "we may undertake to form, *de novo*, all the substances which have been developed from the origin of things, and to form them under the same conditions, by virtue of the same laws and by means of the same forces which nature employs for their formation." Let us hasten to add a distinction upon which Berthelot properly insists, and which it is necessary to recognize, between organs and the matter of which they are composed. "No chemist pretends to form in his laboratory a leaf, a flower, a fruit or a muscle; these questions relate to physiology." This distinction being admitted, and calling to mind the syntheses recently effected, such as the direct preparation of C^4H^4 from carbon and hydrogen, and alcohol from the union of C^4H^4 and water, we may understand the possibility of performing for organic chemistry what has been done for mineral chemistry, and to give to it a basis independent of the phenomena of life.

"I have taken for a point of departure the simple bodies, carbon, hydrogen, oxygen and nitrogen, and I have constructed, by combination of these elements, organic compounds, first binary, than ternary, etc., the former analogous and the latter identical with the proximate principles contained in living beings themselves." Notice the progressive order of these synthetic formations. "The substances which we first prepare by methods purely chemical are the principal carbides of hydrogen, that is to say, the fundamental binary compounds of organic chemistry. As a means of producing all the parts from the

elements themselves, we take oxide of carbon, that is to say, a substance purely mineral, and by the concurrent influence of time and ordinary affinity we combine this oxide of carbon with the elements of water (e. g., by the aid of pressure and the presence of an alkali); we thus obtain a first organic compound, known as formic acid. This acid, united to a mineral base, produces a formate; then, decomposing this formate by heat, we compel the carbon of the oxide of carbon and the hydrogen of the water to combine in the nascent state and produce carbid of hydrogen. Thus there is formed marsh gas, propylene, etc. etc. This is the first step of synthesis."

The hydrocarbons thus prepared become the starting point for the synthesis of alcohols; with marsh gas and oxygen we form methylic alcohol; with olefiant gas and water, ordinary alcohol, etc.

The synthetic production of carbids of hydrogen and of alcohols constitutes the true difficulty, but we know that even in this Berthelot has triumphed. The alcohols once obtained, it is easy to obtain the greater part of the other organic compounds by the ordinary chemical forces. This chemist has thus established the fact that organic chemistry reposes upon the same basis as mineral chemistry.

What has been said of the alcohols may also be said of various other classes of organic compounds, and among others of that new group, which Berthelot calls the *Phenols*, and to which he has devoted a very interesting chapter. *Phenol*, or *carbolic acid*, $C^{12}H^{6}O^{2}$, the type of this group, may also be obtained by direct synthesis.

CHEMISTRY AND MEDICINE.

The following is an extract of a lecture recently delivered in London by Prof. Hoffmann, the well-known chemist:—

Valuable as have been the fruits of chemical inquiry, still more may be expected from the further prosecution of this study. The notion that the action of most of our medicines is chemical, is daily growing into a general conviction. We admit that with every change wrought by pharmaceutical agents in the state of our organism, there occurs a corresponding change in its composition, resulting from their reaction on one or more of its constituents. But of these transformations, which doubtless could be expressed in numbers as definitely as can our laboratory processes, how few are we in a condition to explain; in how few instances has the physician even a vague conception of the mode in which any medicine performs its office! Nobody doubts the power which the principles of the Chinchona bark, or of tea and coffee, exert upon the living body, but we are perfectly in the dark as to the way in which they act upon the animal economy. But if we meet with a series of similar substances in several animal fluids, e. g., *urea* and *creatine* almost constantly present in urine, *glycocoll* generally, and *cystine* occasionally, excreted in the same liquid, and if we find that all these substances exhibit in their chemical relations a close analogy with quinine and theine, we begin to feel a sort of anticipation of the manner in which these agents may act upon the system. Such examples illustrate at once the nature of the aid which the therapeutics may confidently expect from the progress of organic chemistry. Medicine some years ago found itself in a predicament

very similar to that of agriculture at the same period; its resources appeared to be in a state of exhaustion; the rich capital of facts accumulated in the department of organic morphology by the industry of the anatomist, and by the acumen of the physiologist, could not yield its full fruits until an equivalent of knowledge had been drawn from the study of bio-chemical phenomena. This state of things, however, is rapidly changing; associated with chemistry, medicine no longer draws the veil of vitality over processes, the mystery of which may be unlocked by the key of analysis; it no longer shrinks from climbing, step by step, the ladder of recognition, because its upper extremity, disappearing among the clouds, seems to rise forever beyond the grasp of inquiry. The special zeal with which the field of organic chemistry has been cultivated during the last thirty years, the simple and accurate methods which we now possess for determining the composition of organic products, the amount of analysis actually performed, and, more than all, the still untiring energy of the numerous laborers in the same field of investigation, hold out the promise that the connection between medicine and chemistry, becoming daily more intimate, will be productive of benefits, the importance of which we can scarcely venture to estimate in the present state of our knowledge.

NEW CHARACTERISTIC OF THE SO-CALLED SEMI-METALS.

The so-called semi-metals stand between the metals and metalloids, marking the transition between these two classes of elements. They share with the first, — 1. The metallic lustre; 2. Conductivity of heat; 3. Conductivity for electricity; 4. Density.

With the metalloids they possess the property, — 1. Of being acidifiable; 2. Of forming only feeble salifiable bases; 3. Of combining easily with the metals in the manner of an electro-negative body; 4. Some of them form a gaseous compound with hydrogen.

These characters are not absolute, and under them the semi-metals may vary among themselves as much as they differ from other elements; but notice a consideration which enables us to determine nearly where the series of semi-metals begins and ends.

The idea of *malleability* is the one which attaches itself most forcibly to our notice of a metal. The word metal involuntarily recalls a body sonorous, heavy, capable of being hammered and drawn into leaves and wire or extended in the rolls. Viewed from this side, we find certain of the metallic elements which possess neither malleability nor ductility, and, strangely enough, these elements are those which we know as *acidifiable metals*. Among them we find *tellurium*, *tungsten*, *osmium*, *arsenic*, *antimony*, and lastly *bismuth*, which only lately passed among the metals, but which has lately fallen from that rank, since the establishment of its isomorphism with antimony and arsenic — themselves isomorphous with phosphorus and nitrogen.

Bismuth has, in fact, all the external characters of the metals, saving in its want of tenacity and its brittleness, peculiarities common to all the other elements of a metallic lustre, which we call semi-metals.

Wanting tenacity, these elements ought consequently to possess

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little elasticity and sonorousness; but these characters are less obvious, and require experiments to determine them, while it is easy to recognize the character of brittleness and want of tenacity. We propose, therefore, to consider as *semi-metals* those metallic elements which are neither ductile nor malleable, in other words, the *brittle metals.* — *M. Nickles, Silliman's Journal.*

THE MELTING POINTS OF SOME OF THE ELEMENTS.

The following paper, by Mr. William Crosby, an English chemist, we derive from the London *Chemical News:* —

It is remarkable that in almost all the series or groups of the elements mentioned by Mr. Coleman there appears to exist a peculiar relation between the atomic weight and the melting point, which to a certain extent confirms his opinion that the equivalent number of an element expresses a certain amount of force, modified by its atomic volume. As an illustration we will take the group zinc, palladium, platinum.

	At. Weight.	At. Vol.	Melting Point.
Zinc, . . .	33	57	773° F.
Palladium, . .	53	57	Highest heat of wind furnace.
Platinum, . .	98	57	Oxyhydrogen blowpipe.

Here we have a group of elements having a like atomic volume with an increasing atomic weight, not only decreasing in active chemical attraction, but decreasing in fusibility as the weight of the atoms increases. Does the atomic weight here represent a force? We think so, because it appears general. Let us pass on to some other groups.

	At. Weight.	At. Vol.	Melting Point.
Sulphur (crystallized),	16	101	239° F.
Selenium, . .	40	101	420°
Lead, ...	103.7	114	617°
Silver, ...	108	128	1873°
Gold, ...	197	128	2016°
Chlorine (liquid), .	35.5	320	Gaseous at com. temp.
Bromine, . .	80	320	Liquid " " "
Iodine, . . .	127	320	Solid " " "
Aluminium, . .	14	66	Red heat.
Chromium, . .	27	66	Agglomerate but not fuse at the highest heat of the wind furnace.
Molybdenum, .	46	66	
Tungsten, . .	95	66	

Here we have four groups, in each of which the elements having the least atomic weight offer the least resistance, not only to the action of other elements, but also of heat. In so many groups, taken, as it were, at random, it cannot all be accident. There are, however, exceptions: we find them in the following groups: —

	At. Weight.	At. Vol.	Melting Point.
Manganese, . .	27.6	44	Highest heat of wind furnace.
Iron, . . .	28	44	" " " "
Cobalt, . . .	29	44	" " " "
Nickel, . . .	29	44	" " " "
Copper, . . .	32	44	1996° F.
Phosphorus, . .	33	211	111°
Antimony, . .	129	224	Red heat.
Bismuth, . . .	213	270	507°

Manganese and iron, and perhaps cobalt and nickel, follow this law, but copper varies very much; for this we can see no reason. Phosphorus and antimony follow the law, but bismuth comes between. What can influence it? Look at its atomic volume; it differs fifty-nine from that of phosphorus. We cannot, therefore, be much surprised at its having a different melting point.

FUSION OF PLATINUM.

M. Deville, the well-known French chemist, has recently succeeded in rapidly melting thirty-eight or forty pounds of platinum in one mass; — a metal till lately considered almost infusible. This discovery will render the extraction of platinum from the ore more perfect, and, by reducing its cost, will greatly facilitate its application to the arts.

IMPROVEMENT IN THE MANUFACTURE OF IRON.

Prof. Fairbairn, in his address before the British Association, 1861, thus alludes to the recent improvements effected in the manufacture of iron: —

Previously to the inventions of Henry Cort, the manufacture of wrought iron was of the most crude and primitive description. A hearth and a pair of bellows was all that was employed. But since the introduction of puddling, the iron-masters have increased the production to an extraordinary extent, down to the present time, when processes for the direct conversion of wrought iron, on a large scale, are being attempted. A consecutive series of chemical researches into the different processes, from the calcining of the ore to the production of the bar, carried on by Dr. Percy and others, has led to a revolution in the manufacture of iron; and although it is at the present moment in a state of transition, it nevertheless requires no very great discernment to perceive that steel and iron of any required tenacity will be made in the same furnace, with a facility and certainty never before attained. This has been effected, to some extent, by improvements in puddling; but the process of Mr. Bessemer affords the highest promise of certainty and perfection in the operation of converting the melted pig direct into steel or iron, and is likely to lead to the most important developments in this manufacture. These improvements in the production of the material must, in their turn, stimulate its application on a larger scale and lead to new constructions.

A NEW SILVER ALLOY.

M. De Ruolz and De Fontenay, of France, have lately obtained, after several years' experiments, a new alloy, which may be very useful for small coin and for many industrial uses. It is composed of one-third silver, twenty-five to thirty per cent. of nickel, and from thirty-seven to fifty per cent. of copper. Its inventors propose to call it *tiers-argent*, or tri-silver. Its preparation is said to be a triumph of metallurgical science. The three metals, when simply melted together, form a compound which is not homogeneous; and, to make the compound perfect, its inventors have been compelled to use phosphorus and certain solvents which they have not yet specified. The alloy thus obtained is at first very brittle; it cannot be hammered or drawn, and lacks those properties which are essential in malleable metals. But after the phosphorus is eliminated, the alloy perfectly resembles a simple metal, and possesses, in a very high degree, the qualities to which the precious metals owe their superiority. In color it resembles platinum, and is susceptible of a very high polish. It possesses extreme hardness and tenacity. It is ductile, malleable, very easily fused, emits when struck a beautiful sound, is not affected by exposure to the atmosphere, or to any but the most powerful reagents. It is without odor. Its specific gravity is a little less than that of silver. An alloy possessing these properties must be very useful to gold and silver smiths. It can be supplied at a price forty per cent. less than silver, and its greater hardness will give it a marked superiority. It may also serve as a substitute for gold-plated or silver-plated articles, which are now so common on account of their cheapness, but which will not bear replating more than a few times, and which are, in the long run, sometimes more expensive than the pure metal. The new alloy, however, will be most useful for small coin. Its preparation and coinage are so difficult that the coin made of it cannot easily be counterfeited. Its hardness would render it more durable than silver; and thus the expense of re-coining, and the heavy loss arising from the wearing of our silver coinage, would be greatly diminished. — *London Chemical News.*

SILVER TEST.

Silver coins, jewelry, or any other rich alloy, when moistened with a solution of chromic acid, or a mixture of bichromate of potassa and sulphuric acid, become covered with a red purple spot of bichromate of silver. This spot does not occur on poor alloys or metals imitating silver. — *Paris Cosmos.*

NITROGEN AND IRON.

Nitrogen is the most sluggish of all metalloids, or non-metallic elements; and while oxygen displays the most surprising affinity for nearly all the substances we know, nitrogen scarcely combines directly with any, and its combinations must be effected by circuitous routes. Even carbon and hydrogen, for which it has a decided affinity, since with the former it constitutes cyanogen, and with the latter ammonia,

will not unite with it except in a nascent state, that is, while in the act of being evolved. The only two substances known to combine directly with nitrogen are, as MM. Wohler and St. Claire Deville have shown, boron and titanium; the former a metalloid, much akin to diamond, and the latter a somewhat rare metal. In 1829, M. Despretz succeeded in effecting a combination of iron and nitrogen, which before had been considered impossible. On this nitride of iron M. Fremy lately presented a paper to the Academy of Sciences. After confirming all M. Despretz's experiments, he announced a new and easier method by which the nitride of iron may be prepared. This consists in introducing into a porcelain tube about two hundred grammes of anhydrous protochloride of iron, applying a strong red heat, and then making a current of ammonia pass through the tube. This gas will rapidly decompose the chloride, the iron taking possession of the nitrogen of ammonia, and presenting, after the operation, a grayish, and sometimes also a brilliant white metallic appearance. The nitride of iron is very brittle, and is easily reduced to powder; it is less subject to oxidation than pure iron. Nitric acid acts slowly upon it, while, on the contrary, it is rapidly attacked by sulphuric and hydrochloric acid. When dissolved in acids, the nitride of iron is decomposed, and gives rise to salts of iron and salts of ammonia. It is easily and permanently magnetized like steel, but this property is not so strong as in the latter. The nitride of iron will resist a red heat without decomposition, but when heated in hydrogen it yields up its nitrogen, which combines with the former and produces ammonia, and nothing but pure iron is left besides.

DIVERSE ACTION OF ACIDS ON IRON AND STEEL.

M. Saint Eclure, a French chemist, has noticed that when an iron rod is immersed in nitric acid of ordinary strength, the acid boils about the surface of the iron, and this action is continuous; but if steel be used instead of iron, this action of the acid only lasts for a few seconds, and then finally ceases. After the action of the acid has ceased, the steel is said to be in a "passive" condition, and its capability of becoming thus "passive" completely discriminates it from iron. The cause of nitric acid acting upon steel only to a very limited depth, is the accumulation of carbon on the surface, as the iron of the steel is taken up by the acid.

FASTENING OF IRON BARS INTO STONE.

For this purpose, lead is almost always employed, which forms a voltaic couple with the iron, by which that metal is rapidly rusted. Zinc, on the contrary, would preserve the iron. — *Dingler's Polytech. Journal.*

CHEMISTRY OF STEEL.

Much light upon the chemistry of steel has been obtained during the past year, principally through the researches of the well-known French chemist, M. E. Fremy. In a paper communicated to the French Academy, he undertakes to prove that steel is not a carburet

of iron, as has hitherto been supposed, but that there exists a series of combinations of iron with metalloids, metals, and even with cyanides, yielding steel of very good quality. He states, in the first place, that steel, when dissolved in acids, leaves a residue different from pure carbon, but closely resembling certain cyanides. He then proceeds to show that if common iron, in its metallic state, be subjected for the space of two hours to the action of common illuminating gas (carburetted hydrogen) at a red heat, the iron is carbonized and transformed into cast iron, of a gray color, very malleable, and equal to the best specimens produced by charcoal. But if the same gas be brought into contact with nitrogenized iron (nitride of iron), then, instead of cast iron, steel is produced, the good or bad quality of which entirely depends on the quantity of nitrogen previously combined with the iron; if that quantity is sufficient, the result is steel of the finest grain. If, instead of previously nitrogenizing and afterwards carbonizing the metal, a mixture of ammonia and illuminating gas be brought into contact with common iron at a red heat, it then at once absorbs nitrogen from the ammonia, and carbon from the carburetted hydrogen, and steel is obtained of a quality corresponding to the relative proportion of the two gases. Here, therefore, the process of cementation, instead of being effected by charcoal, is accomplished by a gas proceeding from pit-coal. If, conversely, steel be heated in an atmosphere of hydrogen, it loses its nitrogen, and ammonia is produced. Hence, M. Fremy concludes that steel is not a simple carburet, but nitro-carburetted iron; and this is true not only of steel produced in laboratories, but of the common market article.

At the conclusion of the reading of this paper in the French Academy, M. Dumas spoke on the important results which must flow from these discoveries of M. Fremy. The theory of the production of steel, he said, seemed henceforth determined, and it might reasonably be hoped that great practical results would ensue. Who, for instance, did not forsee — and it was for M. Fremy to follow out the demonstration — that great advantage would result from these new, methodical, regular, and certain processes, when there was occasion either to case-harden the surface or edge of certain iron implements or instruments? After having forged, filed, and finished them off in the state of iron, a current of ammoniacal and carburetted gases would convert them more or less completely into steel; the depth of the stratum of steel being regulated by the duration of this gaseous cementation with a certainty never obtainable by cementation with powders, or by the use of horn or animal matters in the empirical processes.

M. Morin remarked that M. Fremy's researches explained numerous empirical receipts and processes for the cementation of steel. In most of these processes, mixtures were employed containing various proportions of carbon, and of more or less nitrogenized substances, such as ammoniacal salts, horn shavings, leather cuttings, soot, etc., etc., the result being a cementation more or less deep, according to the use to which the instruments are to be applied. He thought it necessary, also, to observe that the character of steels produced by different methods varied greatly, not only where these methods dif-

fered, but also with almost identical processes. Moreover, certain kinds of steel, and it seems particularly those obtained by puddling, after undergoing many energetic fagotings, appear to be susceptible of losing their characteristic properties of hardness and elasticity acquired by tempering, and to acquire a considerable resemblance to the most ductile irons. Lastly, the cast steels produced by the new processes of fabrication, when properly forged, possessed an elastic resistance capable of undergoing a much greater strain than those manufactured by the ordinary methods.

M. Chevreul then made the following observations respecting black cast iron and the composition of steels: —

1. *Black Cast Iron.* — At the end of the last century, Proust observed that black cast iron, when heated with weak sulphuric acid, yielded an oily matter, a portion of which was carried off by the hydrogen gas, and made the tubes of the apparatus greasy, while the other portion remained mixed with the black residue, from which alcohol could extract it. I never neglect an opportunity of quoting this observation as an example of the possibility of producing, by chemical forces, compounds analogous to those of organic nature. Experience has long since proved that aqueous vapor, by reacting on charcoal, yields, besides carbonic acid, or oxide of carbon, nothing but hydrogen, and not carburetted hydrogen, as hitherto believed. The combination of the cast steel with the nascent hydrogen seeming to me difficult to admit, this has led me to conjecture that in Proust's experiment the water might assist in the production of the oily matter simultaneously with the carbon and hydrogen. Now, M. Fremy's observations seem to throw a light on the subject, by indicating that it is not carbon, as was represented, which yields the oily matter.

2. *Composition of Steels.* — Independently altogether of science, two bodies possessing different properties have never been confounded; so that when an iron was observed which hardened on being suddenly cooled, it was distinguished from one preserving its original ductility after undergoing the same cooling influence. Thenceforward, the name of steel was bestowed upon the first substance to distinguish it from what is properly called iron; or, in other words, between steel, which tempering hardens, and iron, which tempering does not harden. Since the time of the revival of chemistry, the difference between steel and iron was attributed to the presence of about a thousandth part of carbon in the former. Later, the influence of various bodies on steel was recognized. Berthier mentions chromium; Faraday and Stodart, aluminium, platinum, and its accompanying metals; but the fact which to me seems of the greatest importance, is the method by which MM. Faraday and Stodart obtained from cast iron some centièmes of iridium and osmium, which when analyzed yielded no trace of carbon. Setting aside the question whether steel is an indefinite compound of iron and one or several simple bodies distributed through the whole mass of the steel, or whether it is a definite compound of iron with one or several simple bodies distributed in indefinite proportions in the iron in excess of the elements of the definite compound, I conclude, from the whole of the facts I have stated, that in a chemical treatise steel in general must be regarded not as a definite compound by the nature of its

constituent parts, but as a particular state of iron produced by the union of this metal with bodies the nature of which is variable; and it is from this point of view that, after defining steel, independently of all scientific considerations, as an iron which is hardened by tempering, I would discriminate steels as follows: —

1. Steels formed by iron and carbon;
2. Steels formed by iron, carbon, and a third body;
3. Steels formed by iron and some other body, which is not carbon; or uncarbonized steels.

Professor Fairbairn, in alluding to the discoveries of M. Fremy, in his address as President of the British Association (1861), uses the following language: —

"There is little doubt that in a few years these discoveries will enable Sheffield manufacturers to replace their present uncertain, cumbrous, and expensive process, by a method at once simple and inexpensive, and so completely under control as to admit of any required degree of conversion being obtained with absolute certainty. Mr. Grace Calvert also has proved that cast iron contains nitrogen, and has shown that it is a definite compound of carbon and iron mixed with various proportions of metallic iron, according to its nature."

NEW COMPOUND OF MANGANESE.

Various oxides of manganese have been produced artificially by M. Kuhlmann, by processes described by him in a paper submitted to the French Academy, and printed in the *Comptes Rendus*. Among these artificial products is manganate of lime, a salt remarkable for its decolorizing and disinfecting properties. If this can be economically prepared, a valuable reagent will be abundantly placed at our disposal.

CURIOUS EXAMPLE OF EXPLOSIVE FORCE.

Mr. Robert Mushett, in a communication to the *London Engineer*, states that by pouring melted pig iron into decarbonized metal, a fearful explosion ensues. "This rash act," he says, "of pouring cast iron into decarbonized metal while air is being forced through it was only once committed, and fortunately only a few hundred pounds of metal were being operated upon. But the whole of the metal was projected, as from a gun, into the air, carrying away the top of the furnace, setting the roof of the lofty cast-house on fire, scalding some of the workmen, and nearly terminating the mortal career of Mr. Thomas Brown, who was superintending the operation. It is many degrees more dangerous than setting fire to a magazine of gunpowder."

SILVERING GLASS AND PORCELAIN.

Mr. E. R. H. Unger, in a letter to the editor of the *Chemical News*, states: — "In making various experiments the other day with nitrate of silver, I happened to add to a small quantity of a strong solution of that compound an equally small quantity of a thick alcoholic solution of tannin. The quantity, though small, was exposed with a comparatively large surface to the atmosphere, by making use of a flat-bottomed evaporating dish.

"About a half an hour after, I happened to direct my attention to this dish, and found, to my great surprise, that the surface in the dish was coated with a thin, brilliant, uniform layer of metallic silver. I directly repeated the experiment, and met with the same result again and again. I next proceeded to evaporate the liquid to dryness by placing the dish on the surface of warm sand. As soon as it was completely dry, the coating was found to be so fast on the porcelain that it required the point of a sharp penknife to scrape it off.

"From these experiments I would venture to conclude that porcelain, and any other stony and smooth surface, might be plated with silver, and if so, it might be useful in many of the arts. I would add, in conclusion, that I also succeeded in producing a metallic brilliant coating from a saturated solution of sulphate of copper by the same solution of tannin."

ARTIFICIAL GEMS.

A beautiful red-colored stone, called "Rubasse," has lately been popular in Paris, and brought high prices to the jewellers. Schaffgotsch examined a specimen, and found that, when placed in ammonia, it soon lost its beautiful color, and became a simple piece of rock crystal. It was, indeed, a specimen of quartz, the minute fissures in which had apparently been filled with a solution of carmine.

Artificial Diamonds. — We find a report in French journals, that M. Gannal has succeeded in obtaining crystals having all the properties of the diamond, through the mutual reaction of phosphorus, water, and bisulphide of carbon upon each other, for the space of fifteen weeks. The crystals were found to be so hard that no file would act upon them; they cut glass like ordinary diamonds, and scratched the hardest steel; in brilliancy and transparency they were in no way inferior to the best jewels, and some few possessed a lustre surpassing that of most real stones.

Last, not least, the substance so produced was crystallized in dodecahedra, the crystalline form characteristic of the diamond.

EFFECT OF GREAT PRESSURE ON THE SIX NON-CONDENSIBLE GASES.

At the last meeting of the British Association (1861), Dr. Andrews gave an account of some researches made by him on the changes of physical state which occur when the non-condensible gases are exposed to the combined action of great pressures and low temperature. The gases when compressed were always obtained in the capillary end of thick glass tubes, so that any change they might undergo could be observed. In his earlier experiments the author employed the elastic force of the gases evolved in the electrolysis of water as the compressing agent, and in this way he actually succeeded in reducing oxygen gas to 1-300th of its volume at the ordinary pressure of the atmosphere. He afterwards succeeded in effecting the same object by mechanical means, and exhibited to the Section an apparatus by means of which he had been able to apply pressures which were only limited by the capability of the capillary glass tubes to resist them; and while thus compressed the gases were exposed to

the cold attained by the carbonic acid and ether bath. Atmospheric air was compressed by pressure alone to 1-371st of its original volume, and by the united action of pressure and a cold of —106° Fah. to 1-675th; in which state its density was little inferior to that of water. Oxygen gas was reduced by pressure to 1-324th of its volume, and by pressure and cold to 1-554th; hydrogen, by the united action of cold and pressure, to 1-500th; carbonic oxide by pressure to 1-278th, by pressure and cold to 1-278th; nitric oxide, by pressure to 1-310th, by pressure and a cold of —160° Fah. to 1-680th. None of the gases exhibited any appearance of liquefaction even in these high states of condensation. The amount of contraction was nearly proportional to the force employed, till the gases were reduced to from about 1-300th to 1-350th of their volume; but, beyond that point, they underwent little further diminution of volume from increase of pressure. Hydrogen and carbonic oxide appear to resist the action of pressure better than oxygen or nitric oxide.

PREPARATION OF OXYGEN ON A LARGE SCALE.

H. St. Clair Deville and Debray, the well-known French chemists, in studying the economical production of oxygen upon the large scale, have arrived at results which promise to be of great practical importance. The authors find that sulphate of zinc, when heated alone in an earthen or porcelain vessel, yields a light and white oxide, which may be utilized in painting; sulphurous acid, which is easily absorbed by water; and, finally, pure oxygen. The temperature required is not much higher than that which is necessary for the decomposition of peroxide of manganese.

Another and very elegant process consists in the decomposition of sulphuric acid by heat. A fine stream of the acid is allowed to flow into a retort of about five litres capacity, filled with thin platinum foil and heated to redness. The acid is completely decomposed into oxygen, water, and sulphurous acid, which last is absorbed by an appropriate washing apparatus. The sulphurous acid may again be converted into sulphuric acid, in the usual manner.

In addition, they also state that chlorid of lime (bleaching powders), when heated to low redness, gives off, per pound, from twenty to twenty-five litres of oxygen. This gas is mixed with a little chlorine, from which it may be freed by washing with an alkaline solution, or, better, the formation of this impurity may be prevented by adding enough slaked lime to the chlorid employed that this shall be strongly alkaline; if this precaution be attended to, the operation may be conducted in iron vessels. It is of importance only to avoid heating the mass to the fusion point of the chlorid of calcium. The calcination may be made in glass vessels. The production of oxygen from this source is very regular, and unattended with danger. The process is moreover economical, as compared with those commonly employed by chemists; — in the experiments of the authors the cubic meter (35.316 cubic feet) of oxygen, when prepared from black oxide of manganese, costs about four francs, from chlorid of lime five francs, while from chlorate of potash it could not be obtained for less than ten francs; but the process is nevertheless far more expensive than their sulphuric

acid method, the cubic meter of oxygen having cost in this case not more than one or two francs; and in practice the price would probably be much less than this, since the sulphurous acid might readily be utilized.

It is worthy of remark that the oxygen prepared from sulphuric acid can be easily obtained in a state of chemical purity; that made from black oxide of manganese is always contaminated with nitrogen. —*Ann. de Chim. et Phys.*

PROPERTIES OF LIQUID CARBONIC ACID.

In a recent communication to the Royal Society, Mr. Gore, the well-known physicist, showed how a small quantity of liquid carbonic acid might be readily and safely prepared in glass tubes, closed by stoppers of gutta percha, and be brought in a pure state into contact with any solid substance, upon which it may be desired to ascertain its chemical or solvent action, or be submitted to the action of electricity, by means of wires introduced through the stoppers.

By immersing about fifty substances in the liquid acid, for various periods of time, he has found that it is comparatively a chemically inert substance, and not deoxidized by any ordinary deoxidizing agent, except the alkali metals. Its solvent power is extremely limited. It dissolves camphor freely, iodine sparingly, and a few other bodies in small quantities. It does not dissolve oxygen salts, and it does not redden solid extract of litmus. It penetrates gutta percha, dissolves out the dark brown coloring matter, and leaves the gutta percha undissolved, and much more white. It also acts in a singular and somewhat similar manner upon India rubber. The India rubber, while in the liquid acid, exhibits no change; but immediately on being taken out, it swells to at least six or eight times its original dimensions, and then slowly contracts to its original volume, evidently from expansion and liberation of absorbed carbonic acid, and it is found to be perfectly white throughout its substance. These effects upon gutta percha and India rubber may prove useful for practical purposes.

The liquid acid is a strong insulator of electricity; sparks (from a Ruhmkorff's coil) which would pass readily through $\frac{9}{32}$ds inch of cold air would with difficulty pass through about $\frac{1}{70}$th of an inch of the liquid acid.

In its general properties it is somewhat analogous to bisulphide of carbon, but it possesses much less solvent power over fatty substances.

OZONE, NITROUS ACID, AND NITROGEN.

The following communication has been made to *Silliman's Journal* by T. Sterry Hunt, F.R.S: — The formation of a nitrite when moist air is ozonized by means of the electric spark (the old experiment of Cavendish), or by phosphorus, was shown by Rivier and de Fellenberg, who concluded that the reactions ascribed by Schonbein to ozone were due to traces of nitrous acid. The subsequent experiments of Marignac and Andrews have, however, established that ozone is really a modification of oxygen, which Houzeau has shown to be identical with the so-called nascent oxygen, which is evolved,

together with ordinary oxygen, when peroxide of barium is decomposed by sulphuric acid at ordinary temperatures. The spontaneous decomposition of a solution of permanganic acid also evolves a similar product, having the characters of ozone.

Believing that the nitrous acid, in the above experiments, is not an accidental product of electric or catalytic action, but dependent upon the formation of active or nascent oxygen, I caused a current of air to pass through a solution of permanganate of potash mixed with sulphuric acid. The air, which had thus acquired the odor and other reactions of ozone, was then passed through a solution of potash; by which process it lost its peculiar properties, while the potash solution was found to contain a salt having the reactions of a nitrite.

As I suggested in this Journal in 1848, I conceive gaseous nitrogen to be the anhydrid amid or nitryl of nitrous acid; which in contact with water might, under certain circumstances, generate nitrous acid and ammonia. From the instability of the compound of these two bodies, however, it becomes necessary to decompose one at the instant of its formation, in order to isolate the other. Certain reducing agents which convert nitrous acid into ammonia may thus transform nitrogen (NN) into $2NH_3$. In this way I explain the action of nascent hydrogen in forming ammonia with atmospheric nitrogen, in presence of oxidizing metals and alkalies. (Zinc, in presence of a heated solution of potash, readily reduces nitrates and nitrites with the evolution of ammonia.)

Now an agent which, instead of attacking the nitrous acid, would destroy the newly-formed ammonia, would permit us to isolate the nitrous acid. Houzeau has shown that nascent oxygen is such an agent, at once oxidizing ammonia with formation of nitrate (nitrite?) of ammonia, and thus, when ozone (nascent oxygen) is brought into contact with moist air, both of the atoms of nitrogen in the nitryl (NN) appear in the oxidized state.

From this view it follows that the odor and most of the reactions ascribed to ozone are due to nitrous acid, which is liberated by the decomposition of atmospheric nitrogen in presence of water and nascent oxygen. We have thus a key to a new theory of nitrification, and an explanation of the experiments of Cloez on the slow formation of nitrite by the action of air, exempt from ammonia, upon porous bodies, moistened with alkaline solutions.

THE USE OF OZONE AS A BLEACHING AGENT.

According to M. Gorup-Besanez, ozone, when properly applied, is a most effective and convenient agent for restoring books or prints which have become brown by age, or been soiled or smeared with coloring matter; only a short time being required to render them perfectly white, as if just from the press, and this without injuring in the least the blackness of the printer's ink or the lines of crayon drawing.

As examples of his results, the author mentions a book of the sixteenth century, upon a page of which several sentences had been painted over, by the monks of that epoch, with a black, shining coloring matter, in order to render them illegible, and of which no trace

of a line could be detected. After thirty-six hours' treatment with ozone, the coloring matter was entirely destroyed, and the most careful scrutiny of the page would have failed to discover that any of the lines had once been painted over. In like manner, a wood-cut of Durer, which had been besmeared with a dark yellow color, was completely restored.

Writing ink may be readily discharged by ozone, especially if the paper be subsequently treated with very dilute chlorhydric acid to remove the oxide of iron.

Printer's ink is not attacked by ozone, to any appreciable extent, unless the action be long-continued. Vegetable coloring matters are completely removed by it, but metallic coloring matters, grease spots, and stains produced by fungi, cannot be destroyed.

As applied in the small way, the method consists in placing a bit of phosphorus, about three inches in length, and half an inch in diameter, the surface of which has been scraped bright, in a wide-necked glass carboy, or other large hollow vessel, pouring in as much water, at about 30° Cent., as will half cover the phosphorus, closing the vessel with a cork, and allowing the whole to stand until the jar is charged as strongly as possible with ozone, which ordinarily occurs after twelve or eighteen hours. Then, without removing the phosphorus or water, the paper to be bleached, which has been moistened with water, rolled up, and fastened to a platinum wire in a suitable manner, is hung in the middle of the vessel. The cork is now restored and the apparatus left to itself. The roll of paper is soon surrounded with the fumes arising from the phosphorus, and the stains gradually disappear. The rapidity of the operation, of course, depends upon the nature of the substance to be discharged, three days having been the longest time required in any of the experiments. Prints, which had merely become brown by age, and those stained with coffee, usually become perfectly white and clean in the course of forty-eight hours. The action of the ozone, however, must not be continued too long, lest some of the finer lines of the engraving should be injured. After all the spots have disappeared, the paper is strongly acid, and if allowed to dry when in this condition would become exceedingly brittle and also dark-colored. It is consequently necessary to remove the acid completely. In order to accomplish this, the paper is placed in water, which is frequently renewed, and allowed to lie there until a lot of blue litmus paper, pressed against it, is no longer reddened. The paper is then passed through water to which a few drops of a solution of soda have been added, and is spread upon a glass plate; this is slightly inclined, and a fine stream of water is allowed to flow over the paper during twenty-four hours. After the paper, on exposure to the air, has become dry enough to remove from the glass without danger of tearing, it is taken off and pressed dry between folds of filter-paper. The author remarks that, in case the process were attempted on a larger scale, it would probably be well to have glass troughs or boxes blown, of the desired form, since it is not easy to prepare suitable vessels by any process of fastening together pieces of glass, the cement being attakced by ozone.

Attempts to apply ozone in restoring oil paintings gave only negative results, the action having been irregular.

ATMOSPHERIC OZONE.

The following comprehensive paper on atmospheric ozone was presented to the British Association (1861 meeting) by Dr. Moffatt, F. R. S.:—

The mean daily quantity of ozone is greater with readings of the barometer below than above the mean, and greater when the range of the barometer and the number of its oscillations are above the mean. It is greater when the mean-daily and dew-point temperatures are above the mean, but greater when the degree of humidity is below than when above the mean. When the wind is from points of the compass between north-west and south-east-by-north above the mean number of times, ozone is at its minimum, and when it is in points south of these above the mean number, it is at its maximum. It is also at its maximum when the wind is above its mean force. When rain is above the mean quantity, ozone is also at its maximum, and also with hail; but the quantity is smaller on days with snow and sleet than on days without them. With fog it is below the mean quantity. It is above it with cirri, halos, auroræ, and the zodiacal light, but below it with thunder, thunder and lightning, and thunder storms; and it is at its maximum with negative, and minimum with positive, electricity. The mean daily quantity is greater with decreasing than with increasing readings of the barometer, and it is three times greater with wind in points south of east and west, than it is in points north of these,—the greatest quantity (3.5) with south-west, and the smallest (0.8) in the north-east points. Ozone periods may be said to commence invariably with decreasing readings of the barometer and increase of temperature, and with winds from south points of the compass; and to terminate with increasing barometer readings, decrease of temperature, and wind from north points of the compass. These results are from two hundred and ninety-six periods. By far the greatest number of ozone periods commence in south-east, and a great majority terminate in north-west points. Indeed, although the commencement of ozone periods in north-west points is not uncommon, the south-east may be called the points of their commencement, and the north-west the points of their termination. The quantity of ozone is greater in the night than in the day. It is greater with new and full moons than with the first and last quarters, and it also varies with the seasons. It is greater in January, February, and March, than in April, May, and June; but greater in the latter months than in July, August, and September. In these it is at its minimum, and it again increases in October, November, and December. The greatest quantity is in April (2.3) and December (2.4), and the smallest in July (1.3) and August (1.3). The greatest number of ozone days is in April (25), and the smallest in August (19) and November (17). Whatever tends to a deflection in the direction of the wind leads to a corresponding result in ozone observations, and a town, chemical works, drains, and cesspools, in fact, at any locality in which the products of combustion and decomposition are in sufficient quantity to decompose ozone, the air will be de-ozonized, and the wind or current passing over it will be non-ozoniferous. The quantity of ozone increases with increase of elevation above the level of the sea. The

following results were obtained from observations taken at fifteen stations along a tidal river and its estuary. The stations varied in height from three feet to six hundred feet, and in distance from the river, from its bank to eight miles inland. Some of the stations were in towns and villages; from these we find that ozone, as a rule, increases with increase of elevation and decreases with increase of distance from the river; and that it is invariably in greater quantity in the open country than in towns and villages. This, I believe, is a universal law. It is the same on the Alps as at lower elevations. The following results I obtained from observations forwarded to me by a member of the Alpine Club. The observations were taken at elevations varying from 740 to 8000 feet. The mean daily quantity of ozone from 740 to 2000 feet is 15; from 2000 to 4000, it is 33; from 4000 to 8000, it is 77. (The degree of humidity at the lowest elevation was 58; at the next, 83; and at the last, 83 also.) Ozone is a highly oxidized body, and it is easily decomposed by oxidable substances. If a test-paper prepared with iodide of potassium be freely exposed to the air in a locality where the quantity of these substances is at a minimum, it will in time become deeply colored brown, and ozone will be said to be at its maximum. If a similar paper be placed in a locality where the quantity of oxidable substances is at a maximum, as over or in the neighborhood of drains and cesspools, the paper will remain uncolored, and ozone will be at its minimum; and if the slip that becomes brown be placed in the latter place, it will lose its color. In the first condition the ozone oxidizes the potassium and sets the iodine free. In the second, the ozonized air meets with incompletely oxidized substances, which are more easily oxidable than the potassium; and in the third instance the brown color of the paper is removed by sulphuretted hydrogen. The ocean, with the wind that blows over it, is represented by the first condition, and the land, with its wind bearing the products of combustion and putrefaction, by the second and third conditions. The conditions of an ozone period are undoubtedly those of the south or equatorial or ocean current of the atmosphere, and those of a no-ozone period are as clearly those of the north or polar or land current. With the former we have low readings of the barometer, with the maximum of its range and oscillations, increasing mean-daily and dew-point temperature, maximum of rain, prevalence of cirri, halos, and high winds, with negative electricity; with the latter we have high readings of the barometer, minimum of range and oscillations, decreasing temperature, no halos, no cirri, low winds, settled weather, and positive electricity. The atmospheric conditions, with ozone and those with no-ozone, are so invariable, and ozone periods so frequently commence and terminate with south-east and north-west winds, that the points of the compass might not inaptly be arranged into four sets, namely, the equatorial or ozone points, the polar or no-ozone points, and the transition points — the south-east, or the points of transition from the north or polar to the south or equatorial, and the north-west, or points of change from the latter to the former. In a medico-meteorological sense, I am not prepared to state that atmospheric ozone produces any form of disease, but I have no hesitation in saying that it prevents diseases of the epidemic character, by removing their causes.

The maximum of diseases undoubtedly takes place while the ozoniferous current has the ascendency, but they are of a sporadic nature, and are caused by the vicissitudes of weather, electrical influences no doubt playing an important part. The maximum of deaths takes place while the wind is in north points. By far the greatest number of diseases, however, take place in the north-west and south-east points, or at the commencement of ozone periods, and these are chiefly affections of the nervous and muscular systems, from which it would appear that derangements in the nervous and muscular forces take place at the time of transition from the no-ozone and positively electric, to the ozone and negatively electric current of the air. The diseases peculiar to the calm, which is also a no-ozone condition, are of an epidemic nature, such as cholera and choleraic diarrhœa. These results are deduced from twenty-seven hundred and twenty-seven cases of diseases, and eleven hundred and forty-nine deaths, which occurred at Hawarden in a period of ten years. As the south is the higher and ozoniferous current, and the north the lower and no-ozone current of the atmosphere, in a medico-meteorological sense, there ought to be some analogy between the higher strata of the atmosphere and the south wind, and between the lower strata and the north wind; and observation shows that as regards ozone and deaths they are similar. All who have paid any attention to the atmospheric conditions of a cholera period, must have observed that the readings of the barometer are remarkably high, that they slowly attain their maximum, and that when they begin to decrease they as slowly approach their minimum. While the barometer is increasing, the wind continues to veer from north to north-east and east, until there is a perfect calm. At first the air is clear, and the sky cloudless. The air becomes less clear, it thickens to haze, and the sky can no longer be perceived. There is no ozone, and the brown test-papers rapidly lose their color. At the commencement of the calm there are a few cases of diarrhœa, and as it continues cases take the character of choleraic diarrhœa, and at last a few cases of cholera occur. The calm continues, the haze thickens, and the cases of cholera *pari passu* increase in number and severity. The haze becomes a dry fog, things communicate a gluey sensation to the touch, insects fly about in swarms, and the epidemic reaches its height. The barometer, having reached its maximum, begins gradually to drop, the haze becomes more of the character of a fog, and if it can be seen through, cirri will be seen hovering in the higher regions of the air, or moving slowly northwards. The south current is now approaching, the barometer continues to fall, a gentle motion of the air is perceived from south-east. Ozone is detected; there may be rain; there may be a thunder-storm. The wind increases in power, and ozone in quantity, and cholera disappears. The rationale of this medico-meteorological process is this: — The first part of the process was the north current gaining the ascendency; and, as it is the land current, bearing the products of decomposition, ozone is reduced to its minimum. While the air keeps in motion, these products do not accumulate in great quantity. The barometer begins to drop. The north current falls back, and is succeeded by the calm. The products of putrefaction go on accumulating; there is no renewal of air, and sulphuretted hydro-

gen can now be detected. Cholera cases go on increasing as the poisonous substances accumulate. As the barometer decreases slowly, the south current slowly advances; but that it is advancing is shown by the cirri, the higher strata of the air. The air becomes more moist, because the moist current is approaching. The south or ozoniferous current at last gains the ascendency, and cholera vanishes, because the incompletely oxidized bodies, the poisonous substances, — perhaps hydrocarbons,— are rendered innocuous by the ozonized air affording them oxygen. These views are supported by the facts that diarrhœa and choleraic diarrhœa are most common in the autumn months, and then ozone is at its minimum, and that ozone is invariably absent during cholera periods. Cholera is also observed to advance from east to west; so do the polar current and the calm. I may state also, in support of these views, that during the cholera epidemic at Newcastle, in 1853, the calm prevailed, and ozone was at its minimum. From the 24th of August to the 11th of September, 1854, ozone was only once perceived, and then in a minimum quantity. Cholera was then at its height in London. On the 10th of September I wrote to a friend, stating that the south or ozoniferous current was approaching, and requested him to watch its effects upon the epidemic. On the 11th we had a south wind, with ozone, and from that day the number of cases of cholera diminished. In conclusion, I have to observe, that in making ozone observations the test-paper ought to be kept in the dark; that sulphuretted hydrogen, ammonia, and moisture, cause the loss of color.

INFLUENCE OF OZONE ON ORGANIC SUBSTANCES.

The following valuable contribution to our knowledge of the nature and action of ozone has been published, during the past year, by Mr. T. K. Hornridge, M. D., F. R. C. S., of London. It will be read, we think, with special interest by all interested in medical science.

The discovery by Schönbein of that peculiar condition of oxygen, named by him ozone, and its great differences from ordinary oxygen, all referable to its more energetic oxidizing power, have, for the last few years, attracted considerable notice among experimental physiologists, especially in Germany. It was natural to expect that a substance, capable of acting with energy on various inorganic substances, would be found to possess a similar power over some, at least, of the constituents of the animal frame; and there are, indeed, some phenomena observable in their mutual reactions, which have given rise to the suggestion that ozone may play a great part in the production of the unceasing changes in the animal body.

For a complete elucidation of the subject, it will be necessary for me to prelude my observations with a brief notice of the leading characteristics of ozone, its sources, and its nature. Its great source is unquestionably electricity, whether frictional or dynamic. Hence its presence in abundance in the air after a thunder-storm, in the oxygen generated by the electro-decomposition of water, in oxygen exposed for a time to a bright sunshine, in the air over an evaporating surface, and in the oxygen given off from plants by respiration. Now, this origin of ozone from electricity gave, probably, the first clue

to its nature; and it is now commonly regarded, according to Schönbein's theory, as oxygen in a state of tension or negative polarity. In accordance with this theory, it has been proved that oxygen exists also in the opposite position of positive polarity, or antozone. Not that antozone has ever yet been isolated; the nearest approach to its isolation is found in peroxide of hydrogen; its existence is only inferred from the result of certain experiments. If peroxide of hydrogen be added to a solution of permanganate of potash, both the peroxides are destroyed, *i. e.*, deoxidized, with a large escape of ordinary oxygen — an experiment which can only be explained by assuming that the excess of oxygen in the one peroxide is in an opposite condition of polarity from that in the other, and that they combine to neutralize each other. On this view peroxides are divisible into two classes: the peroxides of hydrogen, the alkalies, and alkaline earths containing antozone; those of the metals, as manganese, lead, cobalt, nickel, and others, ozone. Now, whether, under all circumstances, the generation of ozone is necessarily accompanied by that of antozone, is, as yet, unproved; but there are many facts which render it highly probable. Only a very small proportion of air or oxygen operated on can ever be ozonized (it is estimated at not more than $\frac{1}{1300}$th), probably because it is constantly tending to its own destruction, by reuniting with the antozone. Certainly the action of phosphorus, in the ordinary mode of obtaining ozone, is not limited to its production. Nitric acid is always produced. The water in the vessel has a slight bleaching power (due, probably, to the presence of antozone, to the constant production of which, at least, of peroxide of hydrogen, chlorine owes its bleaching power); and the phosphorus itself becomes changed, as in two sticks used in my experiments, which are completely covered with a black coating of amorphous phosphorus. May not this change be referred to a kind of polarity taking place in the phosphorus simultaneously with that in the oxygen? amorphous phosphorus bearing probably the same relation to ordinary phosphorus that ozone bears to oxygen.

The ordinary action of ozone is one of energetic oxidation. In spite of the small proportion of ozone present, iodine or chlorine is readily set free from its combinations; silver leaf is converted into oxide of silver; even mercury is superficially oxidized; the white oxide of lead is converted into the brown peroxide; and certain noxious gases, as sulphuretted hydrogen, are completely destroyed, as may be readily shown by suspending in ozone a paper black with sulphide of lead; it is rapidly bleached, by conversion into the sulphate. Ozone, therefore, is the great natural scavenger of the air. Hence it is always most abundant where there is least impurity in the air. In mountainous regions, and by the sea, with a sea wind, it is abundant; whereas near large towns, where the wind has passed over the town, it is wanting. Nevertheless, the relation of the presence and abundance of ozone to the presence of certain impurities in the air, especially in relation to the presence of the *materies morbi* of epidemics, is enveloped hitherto in difficulties and uncertainty; due partly, I think, to the insufficiency of the ordinary test of ozone, which may be affected by many gases, necessarily present in the air of large towns (as sulphurous or nitrous acids).

Quantitative analysis has, as yet, been quite unattempted, although by no means impracticable, by a method suggested by Dr. Bernays, viz., an estimate of the alkali set free from the decomposed iodide of potassium. In the list of disinfectants, ozone must occupy a low rank, owing to the very large quantity of ozonized air which would be required for the destruction of any considerable quantity of foul gas which might be present. It might, however, be advantageously introduced into the sick room, when there is no especial source of foul air, and where the frequent introduction of fresh air from without is prevented by the weather.

In the study of the action of ozone on organic bodies, there are three separate classes of phenomena for consideration: — 1st. Its chemical action on pure isolated organic substances. 2d. Its influence on the animal body when inhaled. 3d. Its effect when taken into the alimentary canal.

Of course, many organic substances are perfectly indifferent to the action of ozone. But there is a peculiar class which, though not apparently acted on, or at all altered in constitution by it, are yet capable of absorbing and retaining it in large quantities, and such bodies have been called "ozone-carriers." The principal bodies of this class are distilled or essential oils, especially the oil of turpentine. Oil of turpentine, in fact, has so great an affinity for ozone, that almost all the oil exposed for sale in shops contains it, in consequence of its frequent exposure to the air. The same may be said of oil of cinnamon, and many other essential oils. Oil of turpentine may contain as much as fifty per cent. of its volume of ozone, and is, therefore, a very convenient medium for acting on other organic substances. What change the oil itself undergoes during the process of absorption, or whether, indeed, it undergoes any change at all, or receives the ozone simply as an act of solution, is altogether unproved. It is equally uncertain — it is, indeed, a kind of corollary, from what has just been said — whether the oil is merely the recipient of already formed ozone, or whether it has in itself the power of acting as a sort of polarizing agent to the oxygen, with which it comes in contact, thus generating the ozone. Next to essential oils, the best ozone-carrier is ether. It is, however, more or less changed by the ozone, and it is not capable of absorbing so large a proportion of it.

In Wunerlich's *Archives*, for 1848, Professor Hoppe published a paper, in which he details a number of experiments which he performed on animals, principally frogs and rabbits, illustrative of the effects of this ozonized turpentine when introduced into the system, either by the alimentary canal or through a wound. He shows, indeed, that in large doses it produces intense hyperæmia of the part with which it comes in immediate contact, followed by the general symptoms of irritant poisoning, and ending in general paralysis, especially of the heart, and death. After perusing the details of his experiments, I cannot ascertain that there are any symptoms specially due to the circumstance of the oil being ozonized, except the greater rapidity of its action. It simply appears to act as a more powerful irritant than the unozonized oil, due, in all probability, to some slight alteration in the composition of the oil itself.

These ozone-carriers are, however, of great use in organic investi-

gations, because by their means ozone can be employed in a much more concentrated form than it is ever possible to obtain it in its gaseous condition. Accordingly, there are two methods of ascertaining the influence of ozone on organic substances: one is, to shake the substance in a jar of repeatedly renewed ozonized air; the other, to mix the substance with ozonized oil. The general results of both methods are, of course, the same; but the oil is more rapid and more complete in its action; and it has this further advantage, that by means of Tr. Guaiaci you can ascertain readily the degree of affinity that the substance has for the ozone. Thus, if blood be mixed with the tincture, and then some ozonized oil be added to it, there is instantly a blue color produced, showing that there has been a liberation of ozone from the oil, which, in its passage through the liquid, has acted on the tincture. But if a solution of sugar be substituted for the blood, no such change of color occurs, because the sugar, unlike the blood, has no desire for the ozone, which, therefore, is not set free from the oil.

The general action of ozone on those organic substances which are amenable to its influence, is one of active oxidation; and the study of these actions enables us to trace, in some instances, the stages through which the more complex organic substances pass in their decomposition, as well as to distinguish those which are more fixed in their constitution, and therefore resist the tendency to destruction by oxidation. As a general rule, it is found that those substances which may be oxidized by the action of $Pb\ O_2$, are also readily acted on by ozone. I do not intend, however, to refer to organic substances which are not found in the animal body, but shall speak first of the changes which are observed to take place in blood, under the influence of this agent, partly because they are more marked and more energetic in this fluid than in any other, and partly because they present points of special interest in relation to the vital processes. Blood is very greedy of ozone, *i. e.*, it absorbs it very rapidly and in large quantities, whether from the air or from other solutions. If blood, freed from fibrin, which has been made quite red by shaking with air, be mixed with the ozonized ether or turpentine, it undergoes a gradual change of color; it darkens, becoming like venous blood, and at last it is perfectly black. This change, however, requires, at ordinary temperatures, a time varying from twelve to forty-eight hours; but, if the liquid be kept warm it may be effected in three or four. This change of color appears to denote the commencement of decomposition, or rather of destruction of the corpuscles; for already, under the microscope, they are seen to be altered in shape, distended and globular, many of them burst and broken down, forming a slight deposit of *débris* if allowed to subside. After this, a process of decolorization commences; the blood passes through shades of chocolate to light brown, becoming turbid from the separation of grayish brown flocculi. By further action of the ozone, the solution becomes eventually quite colorless and transparent; the coagulum diminishes, and becomes nearly, but never quite, white. Under the microscope no trace of the corpuscles is to be found, only a few fine granules. The slight remaining deposit is soluble in alkalies, and re-precipitated by acids, and in all respects possesses the properties

of albumen. The evident results of the decomposition are carbonic acid and water. These are the only two that have been proved and attempted to be estimated; but the estimates are unreliable, partly on account of the slowness of the action, and the length of time over which the experiment is necessarily prolonged, and partly because ozone acts energetically on the caoutchouc connections of the apparatus employed. What becomes of the nitrogen is quite uncertain,—whether it is evolved as nitrogen gas, or, what is more probable, helps to form some secondary product, such as leucin, tyrosin, etc.

If the blood, instead of being acted on by ether or oil, is shaken with ozonized air, the same changes take place; but they require a longer time, from twelve to eighteen or twenty days, and the destruction of organic matter is not eventually so complete. If the corpuscles be separated from the remaining constituents of the blood, and dissolved in water, the solution becomes in every respect like the unaltered blood. It is not so with the serum without the corpuscles. If the serum be acted on by the ozonized ether or turpentine, it is rendered turbid, and a slight coagulum is thrown down; but no perfect oxidation can ever be effected. If the serum is acted on by ozonized air, it absorbs ozone rapidly at first; it is decolorized, and deposits a sediment; but even after many weeks there is still a considerable unaltered sediment, the albumen never being so completely destroyed as in similar experiments with blood. A pure solution of albumen from an egg is, indeed, acted on more completely: a very considerable deposit of coagula takes place, and the solution changes color, becoming greenish-yellow, as though the change was due, partially at least, to ordinary decomposition. Afterwards, the coagula redissolve, the fluid clears, and finally, with the exception of a small deposit, it is found to be free from all trace of albumen. But although the action is eventually nearly as complete as in blood, it requires a much longer time; in fact, it is rarely completed under four or five weeks, and is accompanied, as I have already noticed, with some evidences of ordinary decomposition or putrefaction: whereas, the change of blood is much more energetic and rapid, and, if a due supply of ozone is kept up, is never accompanied by any signs of putrefaction. These differences are due to the hæmatin of the blood-corpuscles, which, as is well known, is the great absorbent of oxygen in the body. Now, it is stated, that the blood-corpuscles will absorb much more ozonized oxygen than unozonized; but it is, in fact, uncertain whether this is due to a simple power of absorption and retention, or whether it is not rather due to the fact that they are continually giving up the ozone for the work of destruction, *i. e.*, oxidation of themselves and the surrounding organic matters, a work which ordinary oxygen out of the body is quite incompetent to perform.

The deportment of blood with ozone suggests a few questions of considerable interest. First, it would be important to determine whether the change of color is of the same nature, and due to the same cause, as the change which takes place during circulation in the systemic capillaries; in other words, whether the presence of ozone is the cause of the dark color of venous blood. This question involves the preliminary decision of two points at least: First, whether there

is any source of ozone existing in the body; whether any tissue has the power of exciting the polarity of oxygen, so as to generate ozone as the result of its nutritive processes; and, secondly, what is the meaning and interpretation of the change of color in the blood under the influence of ozone. It has never yet been shown that any such power exists in blood itself; on the contrary, all experiments made for that purpose tend to prove the reverse. Blood shaken with air or oxygen, or left to decompose with free access of air, never, at any time, gives the slightest indication of containing ozone. The same may be said of the various tissues of the body; but this does not show that there is no generation of ozone in the process of growth or nutrition; and when we consider, on one hand, the apparent dependency of the generation of ozone upon electric action; and, on the other hand, the intimate relations between animal nutrition and the nervous system, it must be admitted to be not altogether improbable that the oxygen in the circulating fluids may undergo, partially at least, this change. Blood may be slightly ozonized by being made the medium of a continuous current of galvanism; although it must be admitted that the blood, as it exists in the system, has not yet been shown to contain ozone. It is not difficult, I think, to interpret the change of color which takes place in the blood during the first few hours of the action of ozone. Considering the manifest change in the corpuscles which, subsequently, progresses more rapidly to their entire destruction, I think we may fairly regard it as the first physical sign of their degeneration. Whether any analogous degeneration of corpuscles takes place in the systemic capillaries, as a consequence of their ministration to the function of nutrition is, I suppose, quite uncertain. The immediate physical cause of the change of color appears to be, indeed must be, in both instances the same, viz., an alteration in the shape of the corpuscles, but I do not think there has yet been offered an adequate explanation of the cause of that alteration in the body. But whether the change is due, in the two instances, to the same cause or not, it is clear that it is accompanied by somewhat different conditions, for in the body it is instantaneous, whereas, under the influence of ozone, it requires, under the most favorable circumstances, two or three hours. Caseine behaves towards ozone like albumen, being, indeed, transformed, in the first instance, into albumen. Of the remaining organic substances to be met with in the body, it may be stated, as a general rule, that all those which pass off as pure excretory matters are indifferent, or nearly so, to the action of ozone. Thus bile, when freed from mucus, fat, and coloring matter, is unaffected by it; and, of course, the various constituents of bile, taurine, glycocoll, the organic acids, etc. The same is true of the excretory constituents of the urine, urea, allantoin, alloxan, and kreatin; but uric acid, which is perhaps not a perfect excretion, is readily oxidized, producing allantoin, urea, and oxalic acid. Fibrine is quite unaffected by ozone, which seems to accord with that theory of the nature of fibrine which regards it rather as the product of waste, as worn-out albuminous matter, analogous to an excretion, than as the material of nutrition. There are substances, however, which are unaffected by ozone, but which are oxidized in the system; such are gelatine and sugar.

Experiments on the tissues of the body are of no value, on account of the blood which they contain.

ACTION OF HYDROGEN AT DIFFERENT PRESSURES ON METALLIC SOLUTIONS.

M. N. Békétoff has shown that hydrogen, when under an increased pressure, is capable of precipitating silver and mercury from their saline solutions, and consequently of assuming a place in the series of metallic substitutions.

The following are the conclusions arrived at from a series of experiments: —

1. Common hydrogen, either as a gas or dissolved, displaces certain metals from their solution in acids. The metals with which he succeeded were silver and mercury.
2. This action depends on the pressure of the gas and the dilution of the salt, or, in other words, on the relative chemical mass of the reducing body.
3. It is probable that at higher pressures the experiment will succeed with other metals.

WINE CHARGED WITH GASES.

In a late number of the *Annales de Chimie* appears a letter to the eminent chemist, Dumas, from M. Eugène Maumené, of Rheims, giving the results of experiments, during which by means of the air-pump various wines were saturated with oxygen gas. The pressure of eight atmospheres was employed. After several months no trace of acetic acid or any new compound in the wine was perceived. The champagne so treated was sparkling, and when opened disengaged pure oxygen, which rekindled an extinguished taper with the usual little explosion. The taste of the oxygenated wine is not changed, but it produces, after drinking, a very sensible, comfortable warmth, like that from drinking the best of old wines. M. Maumené also describes oxygenated water as producing, when first drunk, no remarkable sensation; but he thinks that improvement in respiration, and even in digestion, ensued after it had been drunk for several days. He also experimented with protoxide of nitrogen. The wine charged with this gas produced the hilarious effects common to the inspiration of the gas itself.

EFFECTS OF ALCOHOL, CARBONIC ACID, AND THE VARIOUS ANÆSTHETICS ON THE NERVOUS SYSTEM OF ANIMALS.

M. Lallemand communicated recently to the Paris Academy of Sciences a series of experiments, undertaken by MM. Perrin and Duroy, to elucidate this question. Three ounces of alcohol mixed with an equal quantity of water were given in three equal doses, at a quarter of an hour's interval, to a large-sized dog. After the lapse of an hour the animal was in a complete state of intoxication, the muscular system being relaxed, the skin and conjunctivæ perfectly insensible to the touch, the pulse one hundred and twenty, and the respiration twenty-two per minute. The posterior arches of the last three

dorsal vertebræ were now removed, and the spinal marrow laid bare for about two inches of its length. It was then found that the anterior and posterior columns of the cord, and the anterior and posterior roots of the spinal cord, could be pricked, seized with forceps, and pinched or pulled, without eliciting any symptom of sensibility or muscular convulsion. The paralysis of the spinal nervous system was found to be complete. The animal was then let alone for four hours, and at the expiration of that period, the alcoholic lethargy having considerably subsided, the same excitatory manipulations were resumed, and the cord was found to have regained its normal susceptibility, as proved by the appearance of the physiological manipulations usually attendant upon the employment of local stimulation. In order to ascertain the physiological effects of carbonic acid, the following experiment was performed: The same process of vivisection having been accomplished, — namely, the removal of the arches of the last three dorsal vertebræ, — the animal was made to inhale a mixture of carbonic acid gas and watery vapor, and at the end of ten minutes became quite motionless and senseless, the arterial blood having assumed a dark venous hue. It was then found that the posterior columns of the cord, and the posterior roots of the spinal nerves, could be pricked, pulled, or pinched, without the production of any sign of sensibility on the part of the animal; but that if, on the other hand, an anterior root were pricked, or the anterior column of the cord stimulated, convulsive movements were produced in the dog's hind quarters; moreover, that if the sciatic nerve were bared by incision and irritated, the muscles to which it is distributed were immediately thrown into a state of spasmodic contraction. In other experiments oxide of carbon was substituted for carbonic acid with the same results. The deductions drawn by these physiologists from their recent course of investigation tend to establish the fact that alcohol, chloroform, and their "kindred spirits," act primarily on the nervous centres by *their actual presence within the nerve-substance;* whereas the carbonic gases act primarily on the blood only, by the conversion of the arterial into venous blood; the difference of their modes of action being that in the first case the anæsthesia is direct and primitive, and due to the immediate action of the toxical agent on the nerve matter; in the second, it is indirect and consecutive, depending on the action of the modified blood upon the nervous centres. — *Comptes Rendus.*

ACTION OF CHLOROFORM.

The action of chloroform has been attributed by the majority of writers to a special electric affinity for the nervous system with which it is brought in contact by the circulation — a direct power of paralyzing, in a greater or less degree, the various functions of the brain. The researches of Faure and Gosselin have deeply shaken this hypothesis. The late Dr. Snow was impressed with the notion that the insensibility produced stood in direct relation to imperfect oxygenation of the blood. The subject has been investigated by Dr. A. E. Pouson, late of the King's College Hospital, who gives as his conclusions, in a paper read before the Medico-Chirurgical Society,

that the chloroform narcotism is due to the imperfect stimulus of the vital functions by mal-oxygenated blood, and caused by the direct caustic action of chloroform upon the blood, and especially on the blood corpuscles and their cell-walls. If the blood be so much deteriorated as to supply an insufficient stimulus to the heart, death ensues by syncope. If stagnation be effected in the vessels of the lungs, death takes place by suspended respiration.

NEW ANÆSTHETIC.

During the past few months considerable interest has been excited among members of the medical profession by an attempt to introduce into practice a volatile liquid, possessing anæsthetic properties, which is obtained as an incidental product in the manufacture of coal oil. Of the chemical history of this substance — called keroselene by its manufacturers — but little is known. Professor Bacon, of the Harvard Medical School, informs us "that a sample in his possession is of sp. gr. 0.640 at 72° Fah. When heated in a flask containing scraps of platinum foil, it began to boil at about 85° Fah. As the more volatile parts distilled off, the temperature continued to rise, and at 170° about three-quarters of the liquid had evaporated. It continued to boil feebly, but the whole was not converted into vapor until the thermometer had risen considerably above 300°. It is evident that several, perhaps many, hydrocarbons are present, having a wide range of boiling points. Probably the most volatile of them would be gaseous at ordinary temperatures, if isolated. It is remarkable that the keroselene should be so readily and completely volatile at atmospheric temperatures. I found that keroselene and Squibbs' ether, exposed in watch-glasses, lost equal weights in two and a half and three and a half minutes respectively; and the former evaporated completely in about two-thirds of the time required for the ether. The specimen which I examined contained a little *sulphur*. Some sulphur compound was therefore present as an impurity, which would be decidedly objectionable for anæsthetic purposes.

The vapor of this substance possesses very decided anæsthetic properties. This was first accidentally noticed by its effects upon a laborer engaged in cleaning a cistern at a coal-oil manufactory, and afterwards proved by the manufacturer by experiments upon flies and mice. Whether it can be employed without danger as a substitute for ether or chloroform, is as yet undecided. — *Communicated to Silliman's Journal, by F. H. Storer, Esq.*

Turpentine as an Anæsthetic. — Turpentine as an anæsthetic has been employed by Mr. J. Wilmshurst. It is sprinkled on a handkerchief, and applied to the nostrils. In cases of severe neuralgia, cramp, and slight surgical operations, it has been found to allay irritation, and cause a gentle sleep, from which patients awake without headache or any other unpleasant symptom.

LIQUID DIFFUSION APPLIED TO ANALYSIS.

In the following article our readers will find a clear and comprehensive account of the subject of "liquid diffusion," and the recent investigations of Prof. Graham, F. R. S., on the subject. The topic

is one of the most important to which the attention of the scientific world has been recently directed, and heralds a great advance in our chemico-physical knowledge.

To obtain a clear view of the liquid diffusion theory, we must go back more than thirty years, to the period when Dutrochet expounded his important observations on "endosmosis." On the view started by Dutrochet, and founded on his experimental labors, a law was proposed, to the effect that whenever two fluids of different specific gravities, and capable of mixing with each other, are simply separated from each other by a membranous partition, two currents become established, — one a current proceeding from the outer side of the membrane into the fluid on the inner side; the other, a current proceeding from the inner side of the membrane to the fluid on the outer side. The first of these processes was called "endosmosis," the second "exosmosis;" while, lately, the more general term of "osmosis" has been applied to the whole of the phenomena, whether the current set up be mainly from without inwards, or from within outwards.

By a variety of experiments, the phenomena of osmosis have been taught and illustrated since the announcement of Dutrochet's original labors. A glass tube, open at both ends, has been usually employed in the following way. The tube, having had a portion of bladder tied firmly over one of its ends, has been immersed, with the surface of bladder downwards, in a solution of saline or saccharine matter, or into simple water; the inner part of the tube has then been filled with some saline or saccharine solution, miscible with the solution beneath, but of higher specific gravity. The two solutions left in this manner, with nothing separating them except the septum of organic matter, begin to diffuse; a portion of the fluid without passes into the cylinder within, through the membrane, while a portion of the fluid within passes over to the fluid without, also through the membrane. But whenever the experiment is conducted as we have arranged it, whenever, *i. e.*, the inner fluid is of higher specific gravity than the outer, then the diffusion is much more rapid from without, inwards; then, consequently, the fluid in the glass cylinder rises above the level of the fluid on the outer side, and then the phenomenon of *end*osmosis is exhibited. If the conditions are reversed, if the denser fluid is placed in the outer cylinder, and the fluid of lower specific gravity in the inner cylinder, then the current set up, being more rapid towards the denser column, the fluid in the outer cylinder rises above the level of the fluid within, and the phenomenon of *ex*osmosis is exhibited. The transmission of fluids through organic membranes once discovered, the fact soon admitted of demonstration by other methods. For instance, it was shown that the external soft rinds of certain fruits, such as the cherry, could be applied to the purpose of illustration; next it was detected that the animal septum might be replaced by unglazed earthenware; and on these observations the idea was started, and gained a general acquiescence, that any substance, the pores of which were occupied by water, would sustain an uninterrupted liquid communication between two solutions of different densities, and would consequently effect the osmotic process.

Content, for a time, in merely observing the new phenomena, and in applying them to the explanation of the processes of absorption and nutrition, we find, in the first few years following the discovery, but little controversy as to the actual reason why the occurrences observed took place. At first, we believe, it was vaguely suspected that the phenomena were determined by the specific gravities of the two fluids; that, in short, the fluid of highest specific gravity attracted that of lower specific gravity, and thus the main current was set up. This view, although in no way sufficient to account for the facts observed, nor, indeed, based on any logical argument, has, as it were by mere force of verbiage, made its way.

Another hypothesis, invented to explain the occurrence of osmotic currents, referred them to capillary attraction, or to that form of attraction resident in porous bodies by which oil is raised through the wick of lamps, or water through the fibres of cotton immersed in it. Dutrochet himself explained osmosis on this theory, and gave a series of calculations, in which he argued that the capillary ascension of water was twice greater than a solution of salt of a density of 1.12. Thus, if a porous septum, holding a saline solution having a density of 1.12, were brought in contact, on its opposite surface, with pure water, the pure water would enter the pores of the septum, displace the saline matter contained in those pores, ascend into the solution above, increase its bulk, and determine the osmotic current in a direction from the solution of lowest to that of the highest specific gravity.

This theory, largely accepted, was destroyed by Prof. Graham, in his paper on osmotic force, published in 1854. He there showed that the experimental basis of the hypothesis was unsound; that the great inequality of capillary attraction assumed to exist between different solutions had no existence; and that many saline solutions which gave rise to the highest osmose were undistinguishable in capillarity from pure water itself.

In this remarkable paper, the author showed that whenever osmotic action was going on, the intervening septum, whether it consisted of earthenware or of animal membrane, was constantly undergoing decomposition. When membrane was employed, soluble organic matter was always found both in the fluid of the osmometer and in the water of the outer jar after every experiment; the action of the membrane appeared also to be exhaustible, although in a slow and gradual manner. Those salts and other substances, of which a small proportion was sufficient to determine a large osmose, were also shown to be all of the class of chemically active substances, while the great mass of neutral or organic substances, and perfectly neutral monobasic salts of the metals, such as the alkaline chlorides, possess only a low degree of action.

It is impossible to follow the arguments of Prof. Graham through the whole of his earlier paper, which we have just mentioned. Suffice it to say that he announced the following statements: 1. That an obvious and essential condition of osmose consists in a difference of composition of two fluids in contact with the opposite sides of the septum. 2. That with the same solution, or with pure water, in contact with both surfaces of a membrane, there will be no chemical

action; the action will be equal on both sides, and although probably attended with movements of the fluids, yet nothing will be indicated, as the movements, being equal, and in opposite directions, will neutralize each other. 3. That difference of composition in the two fluids is necessary in order that there may be inequality of action on the two sides of the membrane. 4. That no substance appears to be permanently deposited in the membrane during osmosis. 5. That the action upon the membrane is of a solvent nature. 6. That probably the chemical actions on the two sides of the membranes do not depend upon inequality, simply of one kind of action, but upon a difference of chemical actions going on on the two sides of the membrane.

In these observations, and in the various experiments which he instituted, Professor Graham, to a certain extent, traced osmosis to the effects of changes occurring in the intervening septum; and although in 1854 he did not give that defined view of the cause of osmosis which he has since supplied, he removed many preceding errors, and laid the basis for a more comprehensive understanding of the whole subject.

In his latest paper, published during the past year (1861) in the Proceedings of the Royal Society, and entitled "Liquid Diffusion applied to Analysis," he has led us to a new view of the osmotic process, and, without impairing the facts previously observed, has given to them a reading which is at once simple and practical. Still setting aside the idea of capillarity as the cause of the phenomena observed, still setting aside the idea of a difference of specific gravity in two fluids as the cause of the phenomena observed, he has indicated that the phenomena are traceable to an influence exerted on the various substances in water by the membrane interposing, and has accounted for separations, and proposed analytical results, all most singular in character and striking in simplicity.

If Professor Graham be now correct, all chemical substances are divisible into two great families in respect to their diffusive qualities.

The first, or *diffusive* class of substances, are marked by their tendency to crystallize either alone or in combination with water. When in a state of solution they are held by the solvent with a certain force, so as to affect the volatility of water by their presence. The solution is generally free from viscosity, and is always rapid. Their reactions are energetic and quickly effected. To this class he gives the name of *Crystalloids*.

The other class of substances of less diffusibility appear to be typified by animal gelatine. They have little if any tendency to crystallize, and they affect a vitreous structure. To this class he gives the name of *Colloids*.

The distinctions between the crystalloids and the colloids, as chemical substances, are further defined by Professor Graham in the following descriptions: The planes of the crystal, with its hardness and brittleness, are replaced in the colloid by rounded outlines, with more or less softness and toughness of texture. Water of crystallization is represented by water of gelatination. Colloids are held in solution by a feeble power, and have little effect on the volatility of the solvent. They are also precipitated from their solution by the

addition of crystalloids. The solution of colloids has always a certain degree of viscosity or gumminess, when concentrated. They appear to be insipid, or wholly tasteless, unless when they undergo decomposition on the palate, and give rise to sapid crystalloids. Their solid hydrates are gelatinous bodies. They are united to water with a force of less intensity; and such is the character of the combinations in general between a colloid and a crystalloid, even although the latter may be a powerful reagent in its own class, such as an acid or an alkali. In their chemical reactions the crystalloidal appears the energetic form, and the colloidal the inert, form of matter. The combining equivalent of the colloid appears always to be high, and it has a heavy molecule. Among the colloids rank hydrated silicic acid, and a number of soluble hydrated metallic peroxides, of which little has hitherto been known; also starch, the vegetable gums, and dextrin, caramel, tannin, albumen, and vegetable and animal extractive matter. The peculiar structure and chemical indifference of colloids appear to adapt them for the animal organization, of which they become the plastic elements. Although the two classes are widely separated in their properties, a complete parallelism appears to hold between them. Their existence in nature seems to call for a corresponding division of chemistry into a crystalloid and a colloid department.

Although chemically inert in the ordinary sense, colloids possess a comparative activity of their own, arising out of their physical properties. While the rigidity of the crystalline structure shuts out external impressions, the softness of the gelatinous colloid partakes of fluidity, and enables the colloid to become a medium for liquid diffusion, like water itself. The same penetrability appears to take the form of a capacity for cementation in such colloids as can exist at a high temperature. Hence a wide sensibility on the part of colloids to external agents. Another eminently characteristic quality of colloids is their mutability. Their existence is a continued metastasis. A colloid may be compared in this respect to water while existing liquid at a temperature below its usual freezing point, or to a supernatural saline solution. The solution of hydrated silicic acid, for instance, is easily obtained in a state of purity, but cannot be preserved. It may remain fluid for days or weeks in a sealed tube, but it is sure to gelatinize at last. Nor does the change of this colloid stop at that point; for the mineral forms of silicic acid deposited from water, such as flint, are found to have passed, during the geological ages of their existence, from the vitreous or colloidal into a crystalline condition. The colloidal is in fact a dynamical state of matter; the crystalloidal being the statical condition.

The separation of a crystalloid from a colloid is readily effected by a combination of diffusion with the action of a septum composed of an insoluble colloidal material. Animal membrane will serve for the latter purpose, or a film of gelatinous starch, hydrated gelatine itself, albumen, or animal mucus. But much the most effective septum used is paper as it is metamorphosed by sulphuric acid. This is now supplied by Messrs. De la Rue, and has become familiar under the name of "vegetable parchment," or "parchment paper." From sheet gutta-percha a flat hoop is formed, eight or ten inches in diame-

ter by three inches in depth, and one side is covered by a disk of parchment-paper, so as to form a vessel like a sieve. A mixed solution, which may be supposed to contain sugar and gum, is placed upon the septum to the depth of half an inch, and the instrument is then floated upon a considerable volume of water contained in a basin. Three-fourths of the sugar diffuses out in twenty-four hours so free from gum as to be scarcely affected by subacetate of lead, and ready to crystallize on the evaporation of the external water by the heat of a water bath.

In this case, then, the effect of the septum is to produce an unequal action of diffusion, and to cause the separation above described. The explanation of this change depends, according to Professor Graham, not upon any degree of capillarity, but upon the effect of the septum, which is a true colloid. The crystalloid sugar is capable of taking water from the hydrated colloidal septum, and thus obtains a medium for diffusion; but the colloid gum has little or no power to separate the combined water of the same septum, and does not, therefore, open the door for its escape by diffusion, as the sugar does.

This separate inaction of the colloidal septum is defined by Professor Graham under the term *dialysis.* In cases where bodies belonging to the crystalloid series have unequal diffusive properties, they may be separated from each other without any intervening septum; the natural diffusive power of each crystalloid being sufficient to determine its diffusibility. To effect separation of different crystalloids, therefore, mere diffusion in a column of water is necessary. The mixed solution of crystalloids is conveyed by means of a pipette to the bottom of a column of water contained in a cylindrical glass jar. A kind of cohobation takes place; a portion of the most diffusing substance rising and separating from the less diffusive substances, more and more completing as it ascends.

We are thus led by these experimental deductions to give to the phenomena of osmosis a new and distinct reading. The consideration of the properties of gelatinous bodies or colloids appears, Prof. Graham thinks, to show that osmosis is an affair of the dehydration (that is to say, of the removal of water) from the membranous gelatinous septum, under influences having a catalyptic character. The colloidal septum is capable of hydrating itself to a higher degree, in contact with pure water, than in contact with a saline solution; while the saline solution, on its part, removes the water from the membrane and establishes the effect.

In addition to this explanation, we obtain by these new experimental deductions another method of conducting analytical inquiries. For instance, soluble albumen may be obtained in a state of purity by exposing it to the separate action of the colloidal septum, with an addition of acetic acid; or, again, if blood, milk, or other organic fluids, are charged with a small quantity of arsenious acid, and the mixtures so formed are placed upon a membranous septum or dialyser, the opposite surface of the membrane being exposed to water, the greater portion of the arsenious acid will pass through the membrane to the external water in the course of twenty-four hours. In an experiment given by Prof. Graham, the arsenic, thus separated and diffused through the external water, was so free from the organic matter that

it could be precipitated at once by sulphuretted hydrogen and quantity weighed.

To those who know anything of the immense difficulties of separating such a body as arsenious acid from organic matter, by the processes commonly adopted in the laboratory, the value of this process will at once be obvious; for a natural separation of the suspected substance is not merely procured, but the analysis is made without the slightest loss of substance, and by repetition of the process the natural separation may be perfected. It remains for our analysts to determine by direct experiment how far this simple method of inquiry may be extended to every other body of the crystalloidal type.

Finally, the labors to which we have drawn attention have an immediate bearing on the phenomena of life, and on those changes known as nutritive and excretive. As the colloidal condition is a dynamical state of matter, so Prof. Graham suggests that it may be looked on as the probable primary source of the force appearing in the phenomena of vitality as living matter without form; while to the gradual manner in which colloidal changes take place (for they always demand time as an element) may the chronic nature and periodicity of vital phenomena be ultimately referred.

INCREASING THE ILLUMINATING POWER OF GAS.

It has long been known that the light of illuminating gas may be considerably increased by mixing with the gas the vapor of naphtha, benzole, or some other volatile hydro-carbon resulting from the destructive distillation of coal. As this vapor condenses at low temperatures, it cannot be carried through pipes from the gas works, but must be mixed with the gas in the vicinity of the burner.

A late number of the London *Chemical News* contains a report of a series of experiments made in London by Mr. W. Haywood, a gas engineer, to test the advantage of applying this mode of increasing light to the street lanterns. Moorgate Street was selected for the experiment. Six lanterns on one side were provided with the common batswing-burners, burning five cubic feet of gas per hour, and six upon the other side of the street were fitted with thirty-inch burners and with reservoirs of naphtha. The experiment lasted thirty days. The district inspector of the Commission, who saw the lights nightly, reports his opinion that the light on both sides was perfectly equal. Mr. Haywood thinks that the light from the thirty-inch burners was inferior, though very slightly so, to that from the five feet burners. He comes to the conclusion that about three feet of the carbonized gas is about equal to five feet not carbonized. As the naphtha will not evaporate in cold weather, the apparatus will not operate out of doors in the winter, but Mr. Haywood thinks that it will save at least five dollars to each street lantern during the summer months.

COLOR PRODUCTS OF COAL TAR.

Aniline, first discovered in coal tar by Dr. Hoffman, is now most extensively used as the basis of red, blue, violet, and green dyes. This important discovery will probably in a few years render Great

Britain independent of the world for dyestuffs; and it is more than probable that England, instead of drawing her dyestuffs from foreign countries, may herself become the centre from which all the world will be supplied.

Colors of Gems.—It is also an interesting fact that M. Tournet, of France, has lately demonstrated that the colors of gems, such as the emerald, aqua-marina, amethyst, smoked rock crystal, and others, are due to volatile hydro-carbons, first noticed by Sir David Brewster in clouded topaz, and that they are not derived from metallic oxides, as has been hitherto believed.—*Address Pres. British Association*, 1861.

CHEMICAL RESEARCHES ON COMBUSTIBLE MINERALS.

The following important contribution to Chemical Geology was recently communicated to the Paris Academy by the well-known chemist, Fremy:—

My long-pursued studies on vegetable tissues, of which the Academy already knows the principal results, have naturally led me to wish to determine the chemical characteristics of the combustible minerals, and to try to discover whether their constituent materials present any analogy with those forming unaltered vegetable tissues.

Admitting, as do all geologists, that turf, lignite, coal, and anthracite, are formed under different circumstances, and that they appertain to the strata of different epochs, my desire is to discover in these combustibles the degree of alteration of the organic tissue.

In studying turf, I have discovered no really new fact. By the side of the unaltered elementary organs, found in such large quantities in fibrous turf, I have found, according to the degree of alteration the combustible has undergone, various proportions of those brown compounds, neutral or acid, nitrogenized or not, which in our ignorance we designate by the general term of ulmic compounds.

The presence of these bodies, which M. Payen had already investigated, establishes a very clear distinction between turfs and unaltered organic tissues.

The chemical examination of lignites was likely to prove more interesting. In this examination I have taken care to distinguish those specimens still presenting a ligneous organization from those which have the appearance and compactness of coal. The former constitute the xyloid lignite, or fossil-wood; the latter, compact and perfect lignite. Regarding their chemical characteristics, all the varieties of lignite I have examined are included in the two preceding species.

Although the fossil-wood lignite has often the tenacity and appearance of ordinary wood, I have come to the conclusion that in this combustible the ligneous tissue undergoes a great change; trituration reduces it to a fine powder; submitted to the action of a weak solution of potash, it yields to the alkali a considerable quantity of ulmic acid.

The following two reactions establish a very marked difference between ordinary wood and fossil-wood lignite: When nitric acid, by the aid of heat, reacts on wood, it dissolves a portion only of its fibres and medullar rays, and leaves untouched the cellulose matter, which

dissolves without coloration in concentrated sulphuric acid, and possesses all the properties ascribed to it by M. Payen.

Under the same circumstances, fossil-wood lignite is attacked with great energy and completely transformed into a yellow rosin, soluble in alkalies and in excess of nitric acid.

By submitting wood and fossil-wood lignite comparatively to the action of hypochlorites, there is a marked difference in their effects on the two substances.

Hypochlorites react on wood in a manner which may be compared to that of nitric acid. They dissolve rapidly a portion of the fibres and medullary rays, leaving the cellulose untouched.

Alkaline hypochlorites attack fossil-wood lignite, almost entirely dissolving it, leaving only imponderable colorless traces of the fibres and medullary rays.

It results, then, from the preceding facts, that when ligneous tissues arrive at that state of modification constituting fossil-wood lignite, and while preserving the appearance of wood, their substance has undergone a very material modification, and then contains new proximate principles, characterized by their perfect solubility in nitric acid and in hypochlorites.

After determining the chemical characteristics of fossil-wood lignite, it becomes interesting to ascertain whether the compact lignite, in which the texture of the ligneous tissues is no longer observable, and which is black and brilliant like coal, to which it bears so much analogy as to mystify the most experienced, preserves the chemical characteristics of fossil-wood lignite, or whether it resembles coal.

In a geological point of view, the comparative study of fossil-wood lignite, of compact lignite, and of coal, appears to me to be also of great importance. If, in fact, there is a positive connection between the state of alteration of combustible minerals and the age of the strata containing them, it becomes apparent how much geology would benefit by possessing a chemical character, by means of which it would be possible to determine accurately the extent of the modification of an organic body, and of determining the age of the stratum by the state of alteration of the combustible mineral found therein. Therefore I have applied myself to find a series of chemical re-agents acting differently on combustible minerals, and to arrange their varieties conformably to the degree of their modifying action and the chemical characters they would thus present. The re-agents I have employed are potash, hypochlorites, sulphuric and nitric acids. I also take into account the excellent characteristic given by M. Cordier.

I have previously shown that it is impossible to confound ligneous tissue with fossil-wood lignite, the latter being soluble in hypochlorites and nitric acid. Compact lignite, presenting no longer the appearance of organization, could be confounded only with certain varieties of coal. The mode of combustion, the reaction of the volatile products on litmus, and the color of the dust, constitute already distinctive and very important characteristics. To this subject chemical re-agents will give a yet greater degree of certainty. When compact lignite is submitted to the action of concentrated potash, the liquid sometimes becomes colored brown, dissolving a small quantity of ulmic acid; but alkaline liquid does not generally react on the

combustible. Thus a distinction is immediately established between fossil-wood and compact lignite.

I have always observed that the lignites which resist the action of potash are those which, by their bearing, approach nearest to the coal series.

Compact lignites, black and brilliant like coal, dissolve entirely in alkaline hypochlorites, are rapidly attacked by nitric acid, and produce the yellow rosin which I have already mentioned while treating of fossil-wood lignite.

The two characters just indicated prevent, then, the confounding lignites with coals. Coal, in fact, is not dissolved by hypochlorites, and is attacked but feebly by nitric acid. I have submitted to the test of the hypochlorites almost all the important coals belonging to different strata, and have found that these combustibles always resist the action of these chemical re-agents. To me this characteristic appears so valuable that I think were a sample of coal met with slightly attackable by hypochlorites, it would be advisable to examine whether the combustible possessing this exceptionable property were really coal; for it may well be imagined that in coal-fields there may exist vegetable matters unequally decomposed.

Coal and anthracite which resist the action of alkaline and hypochlorite solutions dissolve completely in a mixture of monohydrated sulphuric acid and nitric acid; the liquid takes a very deep brown color, and holds in solution an ulmic compound, which water completely precipitates.

It is not my intention in this paper to consider the influences by which organic tissues are transformed into combustible minerals. I ought, however, here to put on record what seems to me an interesting observation. I have ascertained that ligneous tissue, exposed for several days to a temperature of 200°, undergoes successive modifications, and yields bodies very similar to those found in lignites. The first are soluble in alkalies, and correspond to fossil-wood lignite; the second are insoluble in alkalies, but dissolve entirely in hypochlorites, like compact lignite. These are the new facts which it is my wish to submit to the Academy. Their evident object is to introduce chemical characteristics into the study of combustible minerals, and they appear to me to lead to the following deductions:—

1. By treating combustible minerals by the above-mentioned reagents, it is ascertained that in proportion to the age of the lignite, so the chemical characteristics of the tissues gradually disappear, and the organic matter more resembles graphite, the older stratum whence it is derived. One exception I make in respect of the strata which have been modified under the influence of metamorphism. My researches accord completely with those of M. Regnault, who has already arrived at the same conclusions as myself in his important researches on combustible minerals.

2. The first degree of modification of ligneous tissues, represented by turf, is characterized by the presence of ulmic acid, and also by the ligneous tissues or cellules of the medullary rays, which can be extracted and purified in considerable quantities by means of nitric acid or of hypochlorites.

3. The second degree of modification corresponds to fossil-wood or

xyloid lignite. It is partly soluble in alkali, like the preceding body, but it undergoes a greater alteration, for it dissolves almost entirely in nitric acid and hypochlorites.

4. The third state of modification is represented by compact or perfect lignite. Re-agents indicate in this substance a transition from organic matter to coal; thus, alkaline solutions have generally no effect on perfect lignite; this combustible is characterized by its complete solubility in hypochlorites and nitric acid.

5. The fourth degree of modification corresponds to coal, which is insoluble in alkaline solutions and in hypochlorites.

6. The fifth degree of alteration is anthracite, which is obviously allied to graphite, which resists the re-agents capable of modifying the preceding combustibles, and which is but very feebly attacked by nitric acid.

It is then evident that chemical reactions confirm the classification of the combustible minerals admitted by geologists. I am, however, far from thinking that lignite, coal, and anthracite, which are now characterized by their elementary composition and chemical reactions, constitute the only modifications which organic matters undergo while changing into combustible minerals. There doubtless are intermediate transformations of the organic tissues corresponding to the differences established by commercial practice between the different species of coal and lignites. But are the re-agents sufficiently sensitive to be capable of characterizing these different varieties of the same combustible mineral in glance-coal or smith-coal, or even in the different layers of the same coal-bed? I shall investigate this question in another communication. — *Comptes Rendus.*

VALUE OF DIFFERENT KINDS OF SOAP.

Complaints of consumers in regard to the value, or rather efficacy, of samples of soap, which to the best of the manufacturer's knowledge have been well prepared, are not uncommon. It is very probable that the usual explanation which is offered, whenever a soap fails to fulfil the expectations of the consumer, viz., that it contains too much water, may be in many cases correct. Admitting this, and various other contingencies, which are of importance in deciding upon the value of a soap, there appears to be another obvious reason why different soaps containing equal amounts of water may still possess different degrees of efficacy.

It is evident from the different equivalent weights of the various fatty acids, that the amounts of caustic alkali taken up by them in the formation of soap must be of unlike magnitude. If it be true that the detergent power of soap is entirely dependent upon the amount of alkali which it contains, of course it follows that those soaps which contain the largest proportion of alkali, or, in other words, those containing a fatty acid the equivalent weight of which is small, must be the most efficacious. Since the difference between the equivalents of the common fatty acids is not large, these considerations are, perhaps, of little or no importance in so far as concerns the consumption of soap in household economy, the total amount used in a single family being but small. In a manufacturing establishment, however,

where fifty or a hundred thousand pounds of soap may be used in the course of a year, differences which cannot be deemed insignificant must exhibit themselves.

Calculating from the equivalent weights how much of each of the other soaps would be required to replace one thousand pounds of tallow soap, the following quantities will be found: —

1151	lbs.	of oleic acid	soap,	*i. e.*,	15.1	per cent.	more	than	tallow	soap.
1087	"	palm oil	"	*i. e.*,	8.7	"	"	"	"	"
928	"	cocoa-nut oil	"	*i. e.*,	7.2	"	less	"	"	"

Differences like these must certainly be of importance in practice. —*Bœttger's Polytechnisches Notizblatt.*

METHOD OF DISINFECTING MOULDY CASKS.

The casks are first washed out for about five minutes with an alkaline solution of soda, and then soaked for one or two days with a liquor acidulated with hydrochloric acid.

The committee of the Society for the Encouragement of National Industry report that the process is effective both for wine and beer casks; that it is cheap, and saves great expense.—*Bull. Soc. Encour. l'Indust. Nat.*, May, 1860.

NON-EXPLOSIVENESS OF KEROSENE OIL.

The following article on the above subject has been communicated by Dr. A. A. Hayes, of Boston: —

Some recent cases of accidents arising from the inflammation of oils called "Kerosene," have led to an experimental research on the possibility of danger connected with the consumption of coal oil for affording light.

"Kerosene" is a term applied by the earlier manufacturers to coal oil purified in a special manner, and as a "trade name." But by the public generally this term is applied to all oils made from coal and petroleum.

The purified oil, when properly manufactured, obtained from different kinds of coal, or from petroleum (native oil of the oil springs), has nearly the same constant characters in its finished state. Its character of non-explosiveness, its value for illuminating purposes, and entire safety in use ordinarily, *depend entirely on the skill of the manufacturer, his knowledge, and moral sense in his business transactions.*

By the processes of the manufacture, the standard oils are deprived of their more volatile and inflammable parts, they have high boiling points, and in the character of fixity approach to spermaceti and other oils known as "fixed oils." Like lard and similar oils, they do not emit volatile explosive vapors at common temperatures, and they will extinguish small flames, when these are forced into them, being thus distinguished from volatile oils.

Only after they have been heated to the point at which their vapors rise freely in the air will flame communicate with them and continue to burn. This burning of the vapor is a simple *inflamma-*

tion, not attended by explosion; nor can explosion be produced with the vapor, excepting when we mix a little vapor with a large volume of air and heat the mixture. Hence, practically, the standard oils from the different sources named may be considered safe as fuel for lamps used under all ordinary exposures; and no accident has been traced to the consumption of such oil, notwithstanding the very great extension of its application at present in this way.

The consumers of the standard oils obtained from coal and oil springs should be assured that their supplies were purchased from well-known, reliable manufacturers, and all mixtures of light spirits with alcohol, fusel oil, and turpentine, under the numerous fancy names now so common, should be rejected without hesitation. Any one may apply a simple test of inflammability, by allowing two spoonfuls of the oil, contained in a tea-cup warmed to 75° or 80°, to be brought in contact with the flame of a lamp-lighter. No danger attends the trial, and if the vapor or the oil will inflame, great risk will be incurred in consuming it.

True, explosions occur with the vapors of burning fluid, the light napthas of oil-spring oils and their mixtures; the use of which, since pure coal oils have been introduced, is no longer economical, and has always been attended by wanton sacrifice and exposure of human life.

WRITING INK.

M. de Champnor and M. F. Malepeyre, in their *Manual*, say that Ribaucourt's ink is one of the best at present in use. The formula for its preparation is as follows:—

Aleppo galls, in coarse powder,	8	ounces.
Logwood chips, . . .	4	"
Sulphate of iron, . . .	4	"
Powdered gum-arabic, . .	3	"
Sulphate of copper, . .	1	"
Crystallized sugar, . . .	1	"

Boil the galls and logwood together in twelve pounds of water for an hour, or till half the water has been evaporated; strain the decoction through a hair sieve, and add the other ingredients; stir till the whole, especially the gum, be dissolved; and then leave at rest for twenty-four hours, when the ink is to be poured off into glass bottles and carefully corked.

Mr. J. Horsley gives the following receipt: Triturate in a mortar thirty-six grains of gallic acid with three and one-half ounces of strong decoction of logwood, put it into an eight-ounce bottle, together with one ounce of strong ammonia. Next dissolve one ounce of sulphate of iron in half an ounce of distilled water by the aid of heat; mix the solutions together by a few minutes' agitation, when a good ink will be formed, perfectly clear, which will keep good any length of time without depositing, thickening, or growing mouldy, which latter quality is a great desideratum, as ink undergoing that change becomes worthless. It will not do to mix with ordinary ink, nor must greasy paper be used for writing on with it.—*Chemical News.*

New Indelible Marking Ink.—Dr. Elsner gives the following as

a stamping ink for goods before undergoing bleaching, or treating with acids or alkalies. It consists merely of one ounce of fine Chinese vermilion and one drachm of protosulphate of iron, well triturated with boiled oil varnish.

To remove Ink from Paper.—M. Piesse communicates to the *Scientific American* the following process for removing writing ink from paper: Alternately wash the paper with a camel-hair brush dipped in a solution of cyanide of potassium and oxalic acid; then, when the ink has disappeared, wash the paper with pure water. By this process checks have been altered when written on "patent check paper," from which it was supposed by a recent inventor to be impossible to remove writing.

MANUFACTURE OF PHOSPHORUS.

M. Caie Montrand, applying the knowledge of the fact that, under an elevated temperature, any phosphate of lime mixed with charcoal, subjected to the action of hydro-chloric acid gas, is decomposed, has based upon this reaction a new industrial process for obtaining phosphorus. Burnt bones, reduced to a fine powder, are mixed with wood charcoal in earthen cylinders. When these are raised to a red heat a current of hydro-chloric acid gas is introduced. The phosphate of lime is immediately decomposed, and chloride of calcium, carbonic oxide, hydrogen, and free phosphorus are formed. The last is distilled off and condensed.

IMPROVED DISINFECTANT.

M. Agata, of London, has patented the process of this preparation. He collects the common cockle and other shells found on the seashore, and calcines them in a furnace until they are reduced to a friable condition, and readily broken and powdered. To this powder he adds, first, half the quantity of sulphate of iron, thus producing a fine yellow, inodorous powder, resembling ochre. The material is inexpensive, and it is quick and economic in its action, as it requires but about one part of the disinfectant to one hundred of the matter to be treated. It is more especially intended for all kinds of feculent matter, etc.; when used as a disinfectant for urine, about two per cent. of common tar is to be added.

WHITE GUNPOWDER.

Considerable attention has been given of late to this substance. M. Pohl, a German chemist, in a communication to the Academy of Vienna, states that prussiate of potash 20 parts, sugar 23, and chlorate of potash 49 parts, make good white gunpowder. In exploding this powder, 100 parts of it yielded 47.44 of gaseous products and 52.56 solid residue. Ordinarily black gunpowder furnishes only 31.38 of gaseous products and 68.06 of solid residue. The efficiency of gunpowder is measured by the gases which are produced from it by explosion. An equal weight of white gunpowder will produce 1.67 times the explosive effect of the black. In order to obtain the same effect on projectiles and in mines, only 60 parts of white pow-

der will be required for 100 parts of the common kind. The residue of the white being as 31.53 to 68 of the black, it is more cleanly, while the heat generated when it is ignited is much lower, and a greater number of shots can be fired with it without heating a cannon.

M. Pohl considers that white gunpowder, being more energetic in its action than common black powder, approaches more nearly gun-cotton for efficiency, and it has the advantage over this substance in being more easily prepared, keeping for a longer period of time without change, and is cheaper. This powder is not only easier of preparation than the old, but it may be made in a few hours in great quantities with very simple machinery. M. Pohl states that it is difficult of explosion by pressure and percussion; but Mr. F. Hudson, in a communication to the London *Chemical News*, states that he made several samples according to M. Pohl's receipts, and found that when he mixed the materials moist, then dried them at 150° Fah., the powder was very liable to explode with friction — it was indeed percussion powder. This was not the case when they were mixed dry. He says: "A cannon loaded with white gunpowder goes off on the application of a few drops of sulphuric acid applied at the touch-hole. The property of this gunpowder may possibly be applied to some advantage in the preparation of bomb-shells for long ranges. These shells would not explode until they strike the object, if filled with white powder, and contain a small glass vessel with sulphuric acid. No explosion of the shell would take place in the air, as is too often the case with the ordinary fuse shell."

ARSENIATED ALCOHOL.

Arseniated alcohol has been employed by M. Leprieur for the preservation of specimens in natural history collections, especially insects. The animal tissues to be preserved should be plunged into the liquor shortly after death, and insects while still living, or after suffocation by chloroform or ether vapor. M. Leprieur, who has successfully employed this method for twelve years, adds that the living insect is increased in weight about a fourth after remaining in the liquid twelve hours, and that they retain in their organs quite enough arsenious acid to repel the attacks of larvæ.

A METHOD OF SEPARATING NICOTINE FROM THE SMOKE OF TOBACCO.

In order to separate nicotine from tobacco-smoke, M. Ferrier proposes to furnish pipes and cigar-holders with a tube containing a peculiarly-prepared cotton. He hopes by this arrangement to obviate the inconveniences and dangers incident to the occasional or habitual practice of tobacco-smoking. To prepare the cotton, it is soaked in a solution of tannin, and then dried in the air. When the smoker draws the air through the bowl of his pipe, or the leaves of his cigar, a current of gas and vapor is formed, consisting of air with excess of nitrogen, of carbonic acid, and vapor of water, products of the combustion of the outer layer of the tobacco, and of the empyreumatic matter produced from the portions of tobacco adjoining the burning

surface. When these various products come in contact with the prepared cotton, the latter is moistened by the vapor of water, and the tannin retains the nicotine in chemical combination. The distinguished chemist, Cahours, has repeated Ferrier's experiment, and confirmed his results. He is convinced that by the use of the cotton prepared by M. Ferrier, and removed sufficiently often, the products of the combustion and distillation of tobacco are entirely deprived of nicotine. Barral, without disputing the result of Ferrier's experiments, objects that nicotine is not capable of uniting with tannin, and that the latter substance is not less injurious than nicotine. The conclusion to be derived from these investigations seems to be, that tobacco-smoke which has passed over prepared cotton is not absolutely deprived of its virtue. Besides, it yet remains to be ascertained whether smoke thus deprived of its nicotine would still have the properties required by the smoker. Says Barreswill, it would seem that if tobacco were employed only for its smoke, and not for the physiological effects which the smoke produces, it would be easy to substitute for it some inoffensive substance, or even to abstain entirely from its use, unless, indeed, the mere mechanical operation of breathing gas through the tube of a pipe, or cigar, is not all the pleasure of smoking, or the odor of tobacco, aside from its special influence, does not have a sufficient attraction. It is not difficult to conceive that persons may become habituated to the use of tobacco thus deprived of its peculiar qualities, when we remember that chicory has become a regular article of consumption, being used to make a coffee which may be truly considered as destitute of all virtue.

CURIOUS FACTS IN RELATION TO PICRIC ACID.

Mr. M. Carey Lea, of Philadelphia, states that the characteristic yellow color of picric acid is so powerful that he has found that water is distinctly colored by one-millionth of its weight of the acid. This color is also totally destroyed by sulphuric acid of a certain strength, without in any way decomposing the acid.

Water containing one ten-thousandth of picric acid exhibits a bright yellow color. With one three-hundred-thousandth the color is still distinct, even in a stratum of not over an inch in thickness. But in large quantities a millionth gives a distinct color, as above mentioned.

THE EQUIVALENT OF HEAT.

The mechanical equivalent of heat has been determined by M. Jule, of Manchester. He found that *one unit* of heat, or that quantity of heat which is necessary for raising the temperature of a pound of water one degree centigrade, is equivalent to the mechanical work by which the same mass of water is raised to 423½ metres, or 1389 English feet. When heat produces mechanical power, that is, mechanical work, a certain amount of heat is always lost. On the other hand, heat can be also produced by mechanical power, namely, by friction and the concussion of unelastic bodies. You can bring a piece of iron into a high temperature, so that it becomes luminous

and glowing, by only striking it continuously with a hammer; here mechanical power is converted into heat. If we produce so much heat as is necessary for raising the temperature of one pound of water by one degree, then we must apply an amount of mechanical work equal to raising one pound of water 1389 feet, and lose it for gaining again that heat. By these considerations it appears to be proved that heat cannot be ponderable matter, but a motive power, because it is converted into motion, or into mechanical power, and can be produced either by motion or mechanical power. Now, in the steam-engine, we find the *heat* is the origin of the motive-power, but the heat is produced by burning fuel, and therefore the origin of the motive-power is to be found in the fuel, that is, in the *chemical forces* of the fuel, and in the *oxygen* with which the fuel combines.

The Sun's Heat.—According to the hypothesis of La Place, the universe was formed by a chaos of nebulous matter, spread out through infinite space, this nebulous matter becoming afterwards conglomerated and aggregated to solid masses. Great quantities of this nebulous matter, possibly from a great distance, fall together, and thus their attraction, or the energy of their attraction, was destroyed, and thus heat must have been produced—heat so great that it surpasses all our ideas and all the limits of our imagination. If we calculate this quantity of heat, and suppose that the sun contained the whole of it, and if we suppose that the sun had the same specific heat as water, it would be heated to *twenty-eight millions* of degrees, that is, to a temperature surpassing all temperatures we know on earth. However, this temperature could not exist at any time in the sun, because the heat which was produced by the aggregation of the masses must also be spent partially by radiation into space. Nevertheless, the sun is at present hotter than any heated body here on earth, as is shown by the latest experiments of Kirchhoff and Bunsen on the spectrum of the sun, by which it is proved that in his atmosphere *iron* and other metals are contained as vapor, which cannot be changed into vapors by any amount of heat on the earth.

Conversion of Heat into Mechanical Force in the Body.—Dr. Edward Smith has instituted researches on the amount of air taken into, and of carbonic acid given out, by the lungs of a man while doing work on the treadmill, and he finds that a most astonishing increase of respiration takes place during such work. His experiments showed that, by going in the treadmill at such a rate that if he went up-hill at the same rate he would have risen during one hour 1712 feet, he exhaled five times as much carbonic acid as in the quiet state, and ten times as much as in sleeping. The treadmill is the best method of getting the greatest amount of work from a human body. If we go up the declivity of a hill we raise the weight of our own body; in the treadmill the same work is done, only the mill goes always down, and the man on the mill remains in his place. The human body, if it be in a reposing state, but not sleeping, consumes so much oxygen, and burns so much carbon and hydrogen, that during one hour as much heat is produced as would raise the temperature of a weight of water equal to the weight of the body $2\frac{1}{3}$ degrees Fah., the mechanical equivalent of which is rising 1712 feet; so that the amount of mechanical work done in a treadmill is equivalent to

the whole amount of that which is produced in a quiescent state; but the whole amount of decomposition in the living body is five times as great. Of these five quantities one quantity is spent for mechanical work, and four-fifths remain in the form of *heat*. The production of heat in the body while doing great mechanical work is notorious, and hence we see how much the decompositions in the body are increased thereby. The human body, says Helmboltz, is a better mechanical machine than the steam-engine, only *its fuel is more expensive*, for, if we take any thermo-dynamic engine, we find that the greatest amount of mechanical work which can be gained is an eighth part of the equivalent of the chemical force generated by the combustion of the fuel, the remaining seven-eighths being lost in the form of heat. In the human body, on the other hand, one-fifth of the chemical force is spent in doing mechanical work, the other four-fifths remaining as heat. — *London Chemist, Henry Noad.*

ANIMAL HEAT.

But few subjects have ever proved more rebellious to a satisfactory elucidation and explanation than the *source of animal heat.* The most eminent physiologists of past as well as of the present age have alike exhausted their ingenuity without satisfactory results. Baron Liebig, several years since, gave an explanation, that, from its simplicity and plausibility, acquired pretty general favor; a few, however, were not satisfied with this theory, and their objections are likely to demolish it altogether. Prof. Draper asserts that "in every instance the production of animal heat is due to oxidation taking place in the economy." (*Draper's Physiology*, p. 182.) But where *oxidation* exists, there exists also *deoxidation*, and the latter is as much a cooling as the former is a heating process. We have not space nor inclination to review the several theories that have been proposed to account for the production of animal heat. It may be known to some of our readers that Prof. Bennett Dowler, of New Orleans, has for many years entertained peculiar views upon this subject. In the New Orleans *Medical and Surgical Journal*, for May, he has an article upon the subject, detailing many experiments performed by himself bearing upon his views.

Prof. Draper affirms that "heat depends on the power of the pulmonary engine," and says "the absolute temperature will depend on the respiratory condition." Prof. Dowler opposes this idea, believing that animal heat is not dependent upon pulmonary combustion. We think he has the best of the argument. We have not the space to quote his opinions, but will, as concisely as possible, allude to a few of his more important arguments.

On examining the body after death, he finds the lungs lower in temperature than many other portions of the body; and, in many instances, he has found the heat of the body absolutely to rise for a little time after respiration ceases. In pneumonia and consumption, though in the former the office of the lungs is obstructed, and in the latter much of the lung substance may be destroyed, the heat of the body is usually, and perhaps always, above the normal standard. In sunstroke the respiratory act is very imperfectly performed, and yet it "is the hottest of all diseases."

Prof. Dowler objects to the nutritive theory of heat, that cold-blooded animals are often voracious eaters, and also that the temperature of starving animals may be accelerated rather than diminished. This is not altogether a new idea; the article *Abstinence*, of the *National Cyclopædia* (London, 1847), enumerates the caloric manifestations of the economy during starvation, as follows: "During the first two or three days the temperature is natural, subequently the heat seldom sinks below the natural standard; finally, the skin becomes intensely hot — delirium, coma, etc." This is not in accordance with the statement of Dr. Draper, who says, "A starving animal dies of cold;" or that of Carpenter, who says, "Death by *starvation* is really death by *cold*." M. Savigna was once shipwrecked; many of his companions died of starvation, and he barely escaped the same terrible death. He says, and he speaks knowingly, that "*starvation* is accompanied with a *burning heat*."

In conclusion, we quote a few passages that show Prof. Dowler's views upon the subject of animal heat: "Calorification, like consciousness, understanding, will, vitality, matter, and mind, is an original endowment, inherent in man's constitution, the immediate cause of which is no more explicable by chemistry than man's color, size, altitude, etc." . . . . "Vitalism (the *vis vitæ*), or vitality, is self-revealed, self-evident, and no more demonstrable by experiment, testimony, or reasoning, than consciousness, mind, matter, space, duration. If physiology can claim any vital element or principle, the generation, with the maintenance, of animal heat, takes precedence. — *Am. Med. Monthly*.

APPARATUS FOR RESPIRATION AND PERSPIRATION IN THE PHYSIOLOGICAL INSTITUTE OF MUNICH.

Many methods have been used for determining the quantity of carbonic acid and water excreted by the skin and the lungs; and most interesting results have been obtained by the application of the contrivances constructed by Messrs. Scharling, Vierodt, Valentin and Brummer, Regnault and Reiset, Edward Smith, and others, with which every physiologist and chemist is acquainted. There were, however, two objections to be made to all the methods hitherto used for researches on man and animals, viz., that their degree of accuracy could not be ascertained by cross-experiments with known quantities of carbonic acid, and that man and animals were compelled to respire during the experiments under more or less unusual, troublesome, and therefore unnatural, conditions. Professor Pettenkofer has for years directed his attention to this subject, and has endeavored to ascertain how we might accurately determine the quantity of carbonic acid given off by a man breathing and moving freely in the fresh air, without the intermedium of any apparatus whatever. The researches of Messrs. Bischoff and Voit on the nutrition of carnivora have shown that the carbonic acid which escapes through the skin and the lungs cannot be correctly calculated from the difference of carbon between the ingested food and the ejected urine and fæces, regard being had to the weight of the body; because two unknown substances (carbonic acid and water) escape at the same time, and in

different proportions, through the skin and the lungs. It was, therefore, necessary to determine directly one of the two quantities, and Professor Pettenkofer conceived that this could only be done by conducting a current of air, of known and invariable strength, over a man, and then determining the addition of carbonic acid and water to this current of air.

As pattern for such an apparatus, the learned professor took the ordinary stove of an apartment. As long as there is a thorough draught in the chimney, no smoke escapes through the joinings and the door of the stove; but the air passes from without everywhere on the stove, in order to ascend the chimney. If an accurate measurement of the quantity of air moving in the flue which conducts the smoke from the stove to the chimney can be made; and if the composition of the air which enters and leaves the stove can be ascertained by examining a fraction of it, all conditions are fulfilled which are necessary for showing that which, during combustion in the stove, is mixed with the current of air. Prof. Pettenkofer now thought that it would be the best plan to construct, within a large apartment, a small room of sheet iron in place of the stove. This small room should be of five feet square, and furnished with an iron door, with a sky-light and windows. The latter should be cemented as air-tight as possible, and the walls and the ceiling should be soldered as air-tight as possible. The door should be furnished with movable openings, for rendering possible the entrance of air through other points than on the hinges, according as might be required. On the side opposite to the door two openings, one below and the other above, should pass by two flues outside of the small room, into a single large flue, in which the air streams toward that part of the apparatus which serves as a chimney. This part, which should be placed in another room of the house than that in which the iron room is, should consist of two sucking cylinders with ventilating valves, which should be equally moved, at an *ad libitum* height, by means of a strong clock-work. The falling weight of the clock-work should, in proportion as it sinks, be continually wound up again by means of a small steam-engine, so that an *ad libitum* and invariable quantity of air should be kept streaming through the door of the iron room towards the sucking cylinders. The air would then not be able to arrive in these cylinders before having passed through a continually working apparatus for measuring its quantity. A large gas-meter, of such dimensions that three thousand cubic feet English might be accurately measured with it within the hour, seemed for this purpose to be necessary to Prof. Pettenkofer. In order to examine a fraction of the air which would enter the openings of the door and other crevices that might perhaps exist, and which would stream out through the common flue from the apparatus towards the gas-meter; and in order to calculate from the obtained differences of the water and the carbonic acid that quantity which had been added to them within the apparatus, two aspirators appeared to be necessary, each one of which would suck simultaneously an equal proportion of air. The water mixed with the air should then be absorbed by sulphuric acid, and weighed; the carbonic acid should be measured by sucking the air in fine vesicles through a certain quan-

tity of lime-water, and by ascertaining the quantity of caustic lime contained in the lime-water, by means of trituration with oxalic acid. In order to take a sample of the air which would remain in the iron room, a sucking and pressing pump should then be connected with the flue, by means of which bottles containing from six to eight litres might be filled with air, the carbonic acid of which might be determined by adding lime-water to it. The same pump would also serve for ascertaining, during an experiment, the variations of the carbonic acid in the current of air at different times. A contrivance should also be added to this, by means of which *ad libitum* samples of any amount could be taken, without causing a loss of air for the measurement of the whole current. This could be done by connecting an air-tight bottle with the pump, and completely replacing the air originally contained in the bottle with air from the flue, by setting the pump in motion for some time. The air which would have been pressed out of the bottle should then not be allowed to escape into the atmosphere, but should again, by means of a caoutchouc tube, be conducted back to the current which goes towards the gas-meter, at such a point, of course, where the measurement of the carbonic acid would not be disturbed by it. In order that the current of air might not carry water by evaporation from the large gas-meter, the air should go, previously to entering the gas-meter, through a standing cylinder filled with pieces of moistened pumice-stone. Where the air leaves this latter apparatus, a psychrometer should be connected with the flue, for measuring the temperature and the moisture of the air. At the entrance into the gas-meter, a psychrometer and several nozzles for tubes should be fitted in, before the pumice-stone apparatus, in order to allow taking samples of air, etc.

After Prof. Pettenkofer had communicated this plan to the president of the Academy, Baron von Liebig, and some other colleagues, it was laid before the Technological Committee of that body. This committee made a report on it, in consequence of which King Max gave four thousand florins out of his private purse for the construction of such an apparatus of respiration. This is the first machine of its kind in which observations may be made under normal conditions. One may live in it, as in any well-aired apartment; one may take exercise, work, eat, and sleep in it, according to one's custom. Food and other things may be taken in and out through a movable window in the door of the room without disturbing the experiment, just as we may open the door of a stove, in order to poke the fire, or to take out the ashes, without having to fear an escape of smoke into the room, provided there is a thorough draught in the chimney. Another individual, who is outside of the iron room, to control the experiment, does not, by his respiration, disturb the result in the least, for the quantity of carbonic acid contained in the air which enters the room is continually controlled by one of the two apparatuses, and can therefore be easily subtracted. By means of this ingenious contrivance, all problems in vegetable and animal physiology, as far as an increase or a diminution of carbonic acid and water in the air are concerned, may be solved under normal conditions, and in such an exact manner as was impossible before.

MENTAL LABOR MORE EXHAUSTING THAN PHYSICAL LABOR.

Prof. Haughton, the well-known scientist, of Trinity College, Dublin, in a recent paper, asserts that a man who labors neither bodily nor mentally, but who merely lives, will excrete, for every pound of his weight, two grains of urea per diem. Thus, a man weighing 150 pounds, and engaged in no physical or mental employment, will excrete 300 grains of urea. The urea being the products of the complete decomposition of one of the nitrogenous animal tissues, it is necessary that the man should consume a quantity of food capable of yielding an amount of nitrogen equivalent to that contained in 300 grains of urea. This quantity of food suffices, according to the professor, to keep alive 150 pounds' weight of man, and the work done by the food is termed by the professor *opus vitale*. In the case of a working man of standard (150 pounds) weight, the amount of motive power developed by him is indicated by the quantity of urea eliminated from his body, which, in the case of hard-working laborers, is about 400 grains. We find, then, that a man employed in manual labor, of an unintellectual character, must employ a quantity of food sufficient, by its decomposition, to yield 400 grains of urea, and of this quantity of aliment three-fourths are expended in keeping the body alive, and the remaining fourth in mechanical work — *opus mechanicum*. A man engaged in mental labor eliminates a quantity of urea varying, according to Prof. Haughton's experiments, from 486 grains to 510 grains; clearly proving that mental work causes a much greater waste of tissue than manual labor.

Professor Haughton states that men employed in mere manual routine labor require only a vegetable diet, whilst those who are engaged in pursuits requiring the constant exercise of the intellectual faculties must be supplied with food of a better kind.

INFLUENCE OF THE LABOR OF THE TREADWHEEL OVER RESPIRATION AND PULSATION, AND ITS RELATION TO THE WASTE OF THE SYSTEM AND THE DIETARY OF THE PRISONERS.

The following inquiries in reference to the above subject were made by Dr. Edward Smith, of England, on his own person, in October, 1856, at the Coldbath-fields prison. He worked the wheel during periods of a quarter of an hour each, with intervening periods of rest of a quarter of an hour, in the manner prescribed for the prisoners, and made seven series of observations. The average quantity of air breathed during the labor was 2,500 cubic inches per minute, at a rate of respiration of twenty-five and a half per minute, and a depth of respiration varying from $91\frac{1}{2}$ cubic inches to $107\frac{1}{2}$ cubic inches. The rate of pulsation varied from 150 to 172 per minute. During the intervals of rest he sat quietly, and after thirteen minutes' rest the rate of respiration varied from fifteen to eighteen and a half per minute; the quantity of air respired from 725 cubic inches to 980 cubic inches; the depth from 48 cubic inches to 53 cubic inches; and the rate of pulsation from 97 to 120 per minute. Before he entered upon the inquiry, he breathed, in the standing

posture, about 600 cubic inches per minute, at a rate of fourteen per minute, and a depth of 43 cubic inches, and the rate of pulsation was 75 per minute. Thus, during the exertion, the quantity of air inspired was increased two-thirds, the depth of inspiration two and a half times, and the rate of pulsation two and a half times. The returns during the period of rest show that the effects of the labor had not passed away in a quarter of an hour. Compared with the results in the quiet sitting posture, the author stated that the effect on the respiration was five and a half times, and on pulsation two and a half times as great; and taking together the three and three-quarters hours of hard labor with a similar period of rest, he proved that the effect upon the system of the eight hours' labor was equal to that of twenty-four hours of those not condemned to hard labor; and that, if the whole twenty-four hours were taken together, the effect would probably be two-thirds greater than that of occupations not laborious. He then contrasted those results with others which he had obtained for the purposes of comparison. Thus, fast walking, at upwards of four miles per hour, caused a rate of respiration of 30 per minute, a depth of 80 cubic inches, and a total quantity per minute of 2,400 cubic inches. The rate of pulsation was 130 per minute. Ascending steps at the rate of speed of the treadwheel, viz., 640 yards per hour, caused the rate of respiration to be 22 per minute, the depth 90 cubic inches, and total quantity per minute 1,986 cubic inches, and a rate of pulsation of 114 per minute. Carrying 118 pounds at the rate of three miles per hour induced a rate of respiration of $24\frac{1}{3}$ times per minute, a depth of 90 cubic inches, and a total quantity of 2,141 cubic inches per minute, with a rate of pulsation of 189 per minute. Thus the labor of the treadwheel produces greater effect upon the respiration than any of these modes of exertion, while the effect upon pulsation was greater in the last severe labor only. The total quantity of air breathed per hour upon the treadwheel, if the labor were continuous, would be 150,000 cubic inches, as opposed to 27,000 inches in the quiet sitting posture; and the wear of the system would, upon the known principles of science, be in a somewhat similar proportion. He then proceeds to consider the effect of this exertion upon the system, and shows that the excessive exercise of the lungs and heart must ultimately lead to phthisic, asthma, emphysema, congestion of various organs, and disease of the heart; and in persons with diminished vital capacity of the lungs, and weak hearts, the effect must sooner be very serious. In reference to food, the author is of opinion that the reparative (nitrogenous) food, as flesh and bread, is ample, and requires revision only in the better distribution of it; as, for example, the removal of two or three ounces of the six ounces of cooked meat allowed at the dinner four times per week, to the breakfast, which consists only of bread and cocoa. He also points out the importance, and especially to those who masticate imperfectly, of rendering the meat tender, and of allowing more time between the meal and the return to the hard labor. The great and most serious defect is in the respiratory food, since neither fat not sugar is allowed except in combination, as in the ox-heads, or in the briskets of beef, and in the milk and cocoa. No sugar, lard, suet, bacon, or butter is al-

lowed, and of course beer and alcoholic liquors are excluded; these, with starch, are almost the sole articles of respiratory food. He dwells upon the imperative necessity for an increase of fat, both in relation to the wants of respiration and to the due digestion of starchy food; and under the present system much food must be wasted from non-digestion, and the system must, and often does, decrease in weight. He explains the mode of working the wheel, that the labor is not only in raising the body as the wheel descends, but in maintaining it erect in opposition to gravity, since the centre of gravity is probably external to and in front of the body. He shows that it is an uneven punishment, the inequality not being that of guilt, but of physical conformation and health; that the resistance offered by the wheel is not uniform in various prisons, and has been lessened at the Coldbath-fields prison, and hence that the lives of the prisoners are at the mercy of uneducated engineers; that the old, the tall, and feeble, those having unsound teeth and diseased lungs and heart, those not accustomed to slow walking or climbing, and those with small bones and muscles of the back and upper extremities, must suffer the most; and hence that the punishment falls with different degrees of severity upon different classes of the community. The author points out the fact that weak hearts and lessened vital capacity of the lungs may exist with a fair amount of health, and hence would not be necessarily known to the prisoner, nor, indeed, to the surgeon, except on a minute examination. He expresses his opinion that it is a punishment unfit for the age, as the discontinuance of it in many prisons also implies, and certain, if long continued, to induce disease and premature death; and not only renders the prisoner a greater cost to the community whilst in prison, by reason of the increased quantity of food which the labor demands, but subsequently from a premature old age; and since the labor is not employed to meet the cost of maintenance of those who furnish the power, it is so much of human flesh and life wasted. The author refers in a postscript to the government dietary for prisoners condemned for short periods, and shows that a system which affords only bread and water, or bread and gruel, for the whole diet, must be calculated to injure the health of the prisoners, — a system far more repulsive than the private whippings which have been proposed and opposed.

THE INFLUENCE OF FOODS.

In a paper recently read before the Royal Medical and Chirurgical Society, by Dr. Edward Smith, the well-known English physiological chemist, the author stated that the practice of administering arrowroot, or other fashionable foods consisting of starch, with water, under the impression that it was more nutritious and easier of assimilation than wheat flour, was indefensible; since it did not sustain the vital action to a degree capable of maintaining life, and that nature has not provided starch as food altogether apart from nitrogenous substances. He contrasted the action, or rather want of action, of starch with that of the cereals, and showed that the latter is nearly as great as that of any substances with which we are acquainted. He drew the distinction between an action which increases the ex-

isting amount of vital power, and that which only tends to prevent loss of vital power, — two circumstances which, in practice, are commonly confounded, — and showed that beef-tea, wines, and brandy, can act only in the latter mode, while the cereals act in the first-named manner. Hence, in cases of prolonged exhaustion, where there has long been more waste than supply, the former is not sufficient, and it is essential that the latter be added or substituted. The action of milk is exceedingly analogous to that of the cereals, both in extent and duration, and the combination of the two appears to be the most perfect kind of food. The caseine is to milk what gluten is to bread, and the oil in the milk, with substances (respiratory excitants) which call it into action, act in a manner quite analogous to the common combination of bread and butter, or of a mixture of fat and lean flesh. The author showed that milk and flesh were the best and most natural modes of administering fat, and altogether preferable to the administration of separated oils. He referred to the frequent use of skimmed milk in Germany as a medicinal agent, and of sour milk in Greece and America as a part of food; and explained the action of the former, by its caseine and sugar as respiratory excitants; and that of the latter by the advantage of administering lactic and other acids in that combination in the summer season, and at other times, when the blood, by tending to undue alkalinity, is less capable of carrying on the oxidizing process. He showed that in fevers skimmed milk is preferable to new milk.

As fats lessen the respiratory changes, they ought to be combined with other articles of food which increase their action. The author referred to the importance of determining the seasons for the administration of both fat and starch, and showed that there is less difference in the relative amount of these two substances, used in different climates, than has been commonly believed. He attached importance to the physical properties of fat, and explained the beneficial action of that substance when applied to the skin. He thought this latter mode of employing fat to be especially fitted for cases of debility, with lessened appetite, and perspiring, soft skin, in which state the waste is always greater than the supply. The beneficial action of sugar was insisted upon; and the love of the French for sugar and water was explained by the refreshing coolness, the innocuousness, and the agreeable flavor of the fresh-made beverage, and the great freedom and lightness of the respiration which attend its action. He thought the ill effects of sugar in the healthy system had been exaggerated. The action of animal substances in increasing the respiratory process, in addition to the supply of plastic material, was dwelt upon, and shown to be of great value to the system. These are allied to gluten, and some of them probably act as ferments; and, in illustration, he especially cited cheese, which promotes assimilation if taken in small quantity, but is apt to disturb it if much is eaten. Tea was shown to cause increased waste, and to excite every function of the body, and hence was well fitted to cases where there was a superfluity of material in the system, or where we otherwise desire to induce a temporary increase in the vital action; but is injurious to those who are under-fed, or in any case

where there is greater waste than supply. In illustration, the author cited the increase in the loss of weight in the prisoners at Wakefield when tea was added to their food. The action of tea has been hitherto misunderstood, but the sagacious observation of Liebig as to its analogy with the active principle of the bile was much commended. He (Dr. Smith) recommended its use instead of spirituous liquors by soldiers on march, or otherwise exposed for a lengthened period to great heat; since, by its powerful influence in increasing respiration and the action of the skin, without increasing pulsation, it was particularly fitted to counteract the influence of heat in its tendency to induce heat-apoplexy, or, as more suitably termed by Mr. Longmore, "heat-asphyxia;" twenty-five grains of tea in a concentrated cold infusion, taken every hour or half hour during exposure, would suffice. For similar reasons, he urgently recommended it as an adjunct in the treatment of suspended animation, as from immersion. It has a rapid and accumulative action, so that the small and repeated doses have much greater effect than larger and more isolated ones. It differs from coffee chiefly by increasing the action of the skin, and thereby tending to cool the body, and therefore the two substances are applicable to different conditions of the system. He thought that both, and particularly tea, ought to be more commonly used as medicinal agents. Coffee-leaves he believed to be a valuable febrifuge medicine, and one particularly fitted for cases of nervous excitability.

The author then contrasted the effects of brandy and gin with tea, and showed that in all respects they were directly opposed; but coffee so far resembled them in action that it lessened the action of the skin, and thereby lessened refrigeration. Rum and beer he regarded as restoratives, and the combination of rum and milk as the best restorative employed as food; while brandy and gin simply lessen waste. He regarded all alcohols as having their chief influence in sustaining the action of the heart, and recommended that they should be given in small quantities, and repeated every quarter of an hour or half hour in urgent cases, so as to accumulate their action, rather than allow reaction to follow each dose by permitting a long interval between the doses. He mentioned a case in which he gave six bottles of port wine in forty-eight hours, with the effect of sustaining the patient's life, and reducing the pulse from one hundred and fifty to ninety per minute. He believed that alcohol increased the respiratory action indirectly through the nervous system, and that in fine old wines and spirits this action is lessened by the volatile elements, which have a conservative tendency. He particularly cited the conservative influence of fine old port wine, and the disturbing influence of new and inferior spirits. The primary and secondary action of all alcohols, when taken in an amount to affect the sensorium, was always felt, and the author described the attendant circumstances.

In conclusion, Dr. Smith stated that dislikes for foods are indicative of lessened action, and that other foods of analogous properties should be provided in such cases; and also that it was probable that at least some kinds of azotized substances are more fitted for the hot season, when the chemical changes are greatly reduced, than has been heretofore believed. — *Med. Times and Gazette.*

PHOSPHATED BREAD.

The following article has been communicated to the *Scientific American* by Prof. E. N. Horsford, of the Lawrence Scientific School, Cambridge: —

My attention was called five years since to the necessity of a substitute for cream of tartar, as an article of domestic consumption. It was represented to me by extensive dealers that the production of cream of tartar was no longer equal to the demand, and that the greatly increased consumption in the arts and for culinary purposes had caused its price to rise, until it seemed possible that for some important purposes its further use must be given up. It was also stated that its high price had led to frequent adulterations, some of them of more than questionable character in their relations to health. Upon these representations, I undertook the solution of the problem as one of great public importance.

Among the essential qualities of a substitute for cream of tartar, in the preparation of all forms of light bread, cakes, and pastry, are, that the article should be at least as unobjectionable as cream of tartar in its relations to the animal economy, that it should be pulverulent, and that, when mixed with bicarbonate of soda and flour, it should, on the addition of moisture or application of heat, yield a neutral salt, and set free carbonic acid. If, in addition to these qualities, an article could be devised which should possess, in the form in which it is used, unquestionable excellence as an element of food, its value would be placed beyond doubt.

I tried in a great variety of ways, as numerous others have tried, without success, to find some form of muriatic acid which could be mixed with bicarbonate of soda, so as, after raising the dough or paste, common salt should be found in the product. To this most desirable end insuperable difficulties presented themselves. I sought some form of harmless organic acid, suited to all the conditions of the problem, but this effort and many others were alike fruitless. At length it occurred to me to find, if possible, an acid constituent present in all the cereals and healthful food, and place this in the necessary conditions to fulfil the wants of the problem, and, at the same time, in such form that when taken into the system it would be suited to the agencies there in action, to be absorbed if needed, or readily and healthfully removed if not required. Of all such constituents no one is so important as phosphoric acid. Physiological and chemical research have shown that wherever in the body there is an organ of important functions, there nature has provided a store of phosphates. They are present in the juices, the tissues, the muscles, and in large measure in all the brain and nervous matter, and in larger measure still in the bones. The grains we consume contain them; the flesh we eat contains them; the bones we boil and dissolve contain them. The French army was formerly supplied with rations of dissolved bone, prepared at high temperatures in Papin's digester, in the form of small cakes, which a little hot water resolved into soup. The bran which we withdraw from our wheat contains fourteen times as much phosphoric acid as the flour which we convert into bread. The natural provision in the animal economy for the

removal of surplus phosphates, as in the waste and renewal of the bones, is well known.

All these considerations led me to the conviction that if it were possible to prepare phosphoric acid in some form of acid phosphate of lime, such that, after its action with moist carbonate of soda, it would leave phosphate of soda (a constituent of the blood) and phosphate of lime (an essential constituent of food), and confer upon it the necessary qualities of a dry, pulverulent acid, the end would be so far attained as to justify a practical experiment in domestic use.

I succeeded in producing the article in condition to meet the wants of the problem. I then introduced it into my family for use in all forms, as a substitute for cream of tartar for culinary purposes. When many months of daily use had assured me that my theoretical views were sustained by practical application, I gave it into the hands of friends, whose prolonged experience fully confirmed my own. It has been in constant use in my family now for more than four years; and in the form of yeast powder during this time it has been produced and consumed in all parts of the country to a very large extent, settling, in the most satisfactory manner, all questions as to its serviceability and healthfulness.

ARTIFICIAL LIQUORS.

The popular opinion that so-called *artificial liquors* are prepared from poison, is simply an error, and any person claiming to be a chemist, and at the same time promoting this idea, is, to say the least, expounding something he does not understand. The odors or flavors of flowers, fruits, and wines, as well as of the genuine liquors, are the very same compound ethers that are used for compounding artificial wines or liquors. Thus the butyrate of ethyl, commonly called butyric ether, is the flavoring principle of the pineapple as well as of Jamaica rum, and is therefore used to give to pure alcohol the flavor of rum. The pelargonate and the œnanthylate of ethyl are contained in a great variety of wines, and the same ethers prepared in the laboratory of the chemist, instead of that of nature, serve to flavor weakly-scented wines, and to impart to them a bouquet according to the intent or taste of the operator. The butyrate of amyl, prepared from butyric acid and fusel-oil, in a very minute proportion, constitutes the flavor of brandy. The other ingredients used for making liquors from alcohol, are burnt sugar, and some astringents, such as catechu, kino, or tannic acid. We do not believe that a liquor containing strychnia could be sold, nor one containing dilute oil of vitriol or nitric acid, except in very minute proportion, when they could only do good. Assertions to the contrary are not to be trusted. — *Druggists' Circular.*

NEW VEGETABLE PRINCIPLE.

M. Ad. Chatin announces (*Comptes Rendus*, 1860, p. 810) the discovery of a colorless, neutral, nitrogenized and non-coagulable principle, which he says exists in a notable proportion in all vegetable tissues in process of formation, and which for the present he designates A. This matter exists in all vegetables, and is held in solution

in a juice distinctly acid. Most vegetable acids and dilute mineral acids preserve it from change, but it is quickly turned brown by alkalies. M. Chatin was led to the discovery by observing that certain tissues which are always colorless in a fresh plant are regularly colored brown in old specimens; and that tissues in process of formation, and those which take the most active part in the phenomena of vegetation, show the coloration. He supposed, therefore, that the nourishing juices of vegetables must contain a principle which is colorless in living tissues, but which, on the death of the organs, and from other causes, undergoes a change indicated by the alteration of the color, and is the exclusive cause of the brown appearance of autumnal and dead leaves in general. A, after it has turned brown, may be extracted from autumn leaves by treating them with a mixture of ether and water, the former of which will dissolve the green matter and the latter the brown, but the author does not tell us how we may separate the original colorless A.

AGRICULTURAL EMPLOYMENT OF NODULES OF PHOSPHATE OF LIME.

In the opinion of M. Boblique, the inefficacy of native calcareous phosphates can, in numerous instances, be traced to two principal causes: —

1. To the great cohesion of this substance, which renders assimilation very difficult when it is determined only by natural agents. An attempt has been made to remedy this disadvantage by treating the nodules with powerful mineral acids, but this is a costly method, and might perhaps prove injurious to those lands which do not contain a sufficient quantity of bases in a condition to saturate the excess of acid employed to effect the solution of the calcareous phosphate.

2. To the absence of soluble silica. Now, silica is as indispensable to cereals as phosphoric acid; it forms their skeleton, and to its absence is justly attributed the contingency called "versement." If the soil contains an insufficient quantity of assimilable silica, the stalk does not acquire the properties necessary for a good harvest, and the phosphates added to the soil, under these circumstances, are useless. These considerations have guided me in devising some means to insure the useful employment of the nodules.

Pulverized nodules are mixed with fifty per cent. of their weight of sea salt. This mixture is exposed, in a furnace or cylinder, in a current of steam, to a temperature a little below redness.

If, as is sometimes the case, the nodules do not contain a sufficiency of silica, the deficiency must be made up previous to the operation. The reaction of silica on chloride of sodium in contact with the vapor of water is well known, resulting in the formation of silicate of soda and hydrochloric acid. In this special case the latter acts on the phosphate of lime, from which it takes two equivalents of lime, and gives rise to chloride of calcium and biphosphate of lime. However, all the phosphoric acid does not combine with the lime; it sometimes forms a considerable quantity of phosphate of soda. It is thought that this latter product is chiefly owing to the decomposition of phosphate of iron. All this metal, in fact, is found in the state of

sesquioxide, crystallized in spangles, as has been for a long time established in calcining sulphate of iron with chloride of sodium.

The same process thus furnishes both silicates and phosphates in the dry state without excess of acid, which readily yield to plants not only silica and phosphoric acid, but also a considerable quantity of alkali. — *Comptes Rendus, Chem. News.*

LIME IN AGRICULTURE.

In a paper lately read by Boussingault before the Paris Academy of Sciences, he stated that lime introduced in an arable soil very quickly sets at liberty a certain quantity of azote in the state of ammonia. The elements of the ammonia were before united in insoluble combinations not assimilable by plants, but the action of the lime sets them free, and thus permits a part of the capital buried in the soil to be utilized for the next crop. Boussingault thinks that certain mineral matters, such as potash and silica, may be liberated in the soil by the lime; that other substances injurious to plants are destroyed or modified by the same agent, and that to these effects is added besides a physical action, changing the constitution of the land. The action of lime is thus excessively complex, and its good effects can only be explained by studying attentively the special circumstances under which they are produced.

PRESENCE OF PHOSPHORIC ACID IN THE IGNEOUS ROCKS. BY JAMES SCHIEL.

Descending from the Sierra Nevada into the plains of the Sacramento River, by the route which leads along Black Bute, we meet, west of the Bute, with a phosphoritic trachyte crumbling into pieces and covering the surface for many miles. As there is hardly a trace of organic substance to be discovered in the soil from which a luxuriant vegetation is springing, it was to be expected that the rock contained phosphoric acid.[1] This an analysis showed to be the case. The phosphoric acid is contained in the precipitate obtained by ammonia after a pulverized portion of the rock has been disintegrated by fluohydric acid, heated and dissolved in chlorhydric acid. The washed precipitate is dissolved in a small quantity of hot chlorhydric acid, much tartaric acid and some sulphate of magnesia added, and then the phosphoric acid precipitated with an excess of ammonia; the crystals of the phosphate are formed immediately. The amount of phosphoric acid contained in the rock was thus found to be 0.26 per cent., corresponding to 0.78 per cent. of phosphate of lime. — *Silliman's Journal.*

SOME POINTS IN CONNECTION WITH THE EXHAUSTION OF SOILS.

The following is an abstract of a paper on the above subject read at the meeting of the British Association, 1861, by Messrs. Lawes and Gilbert, the well-known agriculturists: —

[1] Fownes (*Prize Essay*, 1845) demonstrated the general presence of phosphoric acid in crystalline rocks. — ED.

The question of the exhaustion of soils is one of peculiar interest at the present time, not only on account of the great attention now paid to the waste of manuring matters discharged into our rivers in the form of town sewage, but also from the fact that Baron Liebig has recently maintained that our soils were suffering progressive exhaustion from this cause, and predicts certain, though it may be distant, ruin to the nation if our modes of procedure be persevered in. The question was one of chemical facts; and the authors had it in view to treat it much more comprehensively than they were enabled to do on the present occasion. They proposed, by way of illustration, to bring forward one special case of progressive exhaustion, occurring in the course of their own investigations, and then to contrast the conditions of that result with those of ordinary agriculture. They had grown wheat for eighteen years consecutively on the same land, both without manure and with different constituents of manure, and they had determined the amounts of the different mineral constituents taken off from each plot. Numerous tables of the results were exhibited. The variation in the composition of the ash of both grain and straw, dependent on variation of season, was first pointed out. Reverting to the main subject of inquiry, it appeared that when ammoniacal salts were used alone, year after year, on the same land, the composition of the ash of both grain and straw showed an appreciable decline in the amount of phosphoric acid, and that of the straw a considerable reduction in the percentage of silica. The average yield of mineral constituents was very much increased by the use of ammoniacal salts, much more so than when a liberal supply of mineral constituents alone was used. But in neither of these cases was there anything like the yield of mineral constituents that was obtained when the ammoniacal salts and mineral manures were used together, or when farm-yard manure was employed. The greatest deficiency indicated was in the silica and the phosphoric acid; and next in order came potash and magnesia. The exhaustion here apparent was, however, not to be wondered at, when it was considered that in these experiments, in which both corn and straw had been annually removed without the usual periodic returns of farm-yard manure, there had been taken from the land, by the use of ammoniacal salts alone, for sixteen years, as much silica as would require four hundred years, and as much phosphoric acid as would require thirty-two years, and as much potash as would require eighty-two years of ordinary rotation with home manuring, and selling only corn and meat, to remove. Again, in the experiments of the Rev. Mr. Smith, of Lais-Weedon, on the growth of wheat year after year on the same land, the authors estimated that he annually took from each acre about seven times as much potash, about three and a half times as much phosphoric acid, and about thirty-seven times as much silica, as the ordinary course of practice would do; and yet, after some fifteen years, his crops were said to be not at all failing. The authors did not recommend such practice as that quoted either from their own or Mr. Smith's experiments; but the instances given showed the capabilities of certain soils; and in one case the conditions under which the point of comparative exhaustion had been reached. It was of course impossible to state the limits of the capa-

bility of soils generally, so infinitely varied was their composition; but it would be useful to give an illustration on this point. Taking the average of forty-two analyses of fourteen soils, of very various descriptions, it was estimated that it would require, of ordinary rotation with home manuring, and selling only corn and meat, about two thousand years to exhaust the potash, about one thousand years to exhaust the phosphoric acid, and about six thousand years to exhaust the silica, found to be soluble in dilute hydrochloric acid, reckoning the soil to be one foot deep. Many soils doubtless had a composition inferior to that here supposed. In a large proportion, however, the amounts of the constituents assumed to be soluble in dilute acid would probably be available for plants before the expiration of the periods mentioned; whilst in a large proportion there would still be further stores eventually available, within a greater or less depth from the surface. But in practice the exhaustion was really by no means so great as supposed in the above illustrations. Where there was no import of cattle food, or artificial (as town) manures, the sale of mineral constituents in corn and meat would be much less than were taken in the authors' estimates. Those amounts of exports from the farm could only be reached when cattle food, or direct manures, were purchased by the farmer; and wherever these courses were pursued judiciously, there was always much more phosphoric acid (the most easily-exhausted constituent) brought upon the land than could be exported in the increase of produce obtained. In such cases, in many soils, potash was more likely to become deficient. Then, again, a not inconsiderable portion of the refuse of our towns was derived from imported food, or other matters not obtained from our own cultivated land; whilst by no means the whole of it reached the sewers, and thence our rivers. In conclusion, whilst the authors believed that modern practices did not tend to exhaustion in anything like the degree that had been supposed by some, they would nevertheless insist upon the importance of applying to agricultural purposes as much as possible of the valuable manuring matters of our towns. It was at the same time certain that if these were to be diluted with water in the degree recognized under the present system, they could then, unless in exceptional cases, be only applicable on the large scale to grass land; and, so far as this was the case, they would, of course, not directly contribute to the restoration to the land under tillage of the mineral constituents sent from it in its produce of corn and meat.

EXTRACTION OF BUTTER.

We herewith give the results of a series of experiments made by M. Barral, on the above subject, as reported in "*Cosmos*" (Paris). The time required for the formation of butter varies considerably with the temperature. At 53° Fah., about ten times more time is required than at 68°; at 86° the time needed is about one-half less than at 68°. Another remarkable fact is, that when the temperature of the churning is too elevated, the yield of butter diminishes very considerably. The most suitable temperature when milk is operated on is between 64° and 68°. The loss is much less when cream is churned instead of milk. The most suitable temperature for obtain-

ing from cream the greatest amount of butter in the shortest possible time is between 57° and 60°. With the same apparatus, by varying the temperature, the duration of the operation may be varied in the proportion of ten to one, while very variable amounts of butter are produced.

SOIL ANALYSIS.

In a review of the agricultural chemistry of the Geological Surveys of Kentucky and Arkansas, communicated to *Silliman's Journal* (Sept., 1861), by Prof. S. W. Johnson, the author makes the following common-sense observations on the general value of soil analyses to agricultural science. He says: —

Years ago, following the teachers of agricultural chemistry in this country and England, we believed that soil-analyses were adapted to be of exceeding use to farmers. Having practised analytical chemistry sufficiently to undertake the work, we proceeded, when on a vacation visit, to collect some farm soils for the purpose of applying our skill and knowledge. On putting down the spade and post-auger into the drift overlying the lowest Silurian of Northern New York, we were at once struck with the difficulty of procuring an average specimen. The soil, for a depth varying from two to six inches, was quite fine, but below that depth largely mixed with gravel. On comparing different samples taken from a small area, it was plain that the soil was not a fit subject for analysis. The relative quantities of organic matter, as indicated by the color of the surface of small stones — some quartz and granitic, others slate and limestone of several geological members — were astonishingly variable. Here we found the soil sandy, there it was clay. To take a sample from one place was to do obvious injustice to the sixty-acre field. To take it from a dozen places would not render the selection of a fair sample any more certain. Then, as to depth, was it proper to go down six inches, one foot, or how far? Had the field been a bed of iron ore, assays of a dozen samples taken from different parts would have indicated very satisfactorily the general value of the deposit, would have served as data for buying and selling the property, because the worth of an unworked bed of such ore depends less upon its content of iron than upon external circumstances which affect the extracting of the metal. Had the field been covered with rich-dressed copper ore to the depth of six inches, it would have been necessary to divide it up into small parcels of a few tons, average these carefully, and as carefully assay each one. No one would risk purchasing a hundred thousand tons of copper ore on the analysis of one or of a dozen samples, because it is impracticable to intermix or average such a mass of material as that a dozen samples shall accurately represent it.

We hold it, therefore, as the first objection to soil analysis that to procure a specimen which accurately and *certainly* represents a field or district, is practically impossible in a majority of cases, *and, if possible, requires a series of analyses to prove the fact.* This argument applies with the greater force when we consider how small a proportion of the ingredients of a soil are of any immediate use in feeding crops. The really active nutrient matters of a soil are not

reckoned by per cents nor by tenths of per cents, but by the minutest fractions.

A heavy crop of thirty-seven bushels of wheat, grain and straw included, removes from an acre of land but three hundred pounds total of mineral matters; and the annual removal of the heaviest crop of wheat from a soil for one hundred years diminishes its mineral matters by less than 0.4 per cent. If, then, in the selection of a sample, the average composition is departed from to the amount of four parts in one thousand, the analysis may represent the soil by the value of three thousand seven hundred bushels of wheat per acre, or by what represents, so far as mineral ingredients can, the fertility of a century.

What freaks and accidents is not the soil analyst the sport of? A bird, squirrel, or dog, relieving nature at the spot where he collects his sample, innocently magnifies the phosphoric acid or alkalies of the surrounding acres a hundred fold. The soil gathered toward the end of a long rain, whereby its soluble matters are carried deep into the subsoil, is declared poor, by analysis, whereas, if taken after a fortnight of drought, it might appear extraordinarily fertile. Boussingault found in his rich garden-soil in June, during wet weather, 0.00034 per cent. of nitric acid. In the following September, after a period of dryness, it contained 0.0093 per cent., or twenty-seven times as much as in June. This ingredient is indeed more liable to fluctuation in amount than any other, both because it is formed in the soil, and because it is not subject to the absorbent action which the soil exercises over most other of its soluble constituents; but the same variation occurs among the other ingredients according to the direction of the capillary movement of the soil-water, though in less degree.

Independently, however, of all considerations and calculations like the above, we have proof — evidence at least that supports these considerations, and has never been publicly refuted — that it is practically impossible to obtain average specimens of the soil. I refer to investigations made as long ago as 1846–9, under the direction of the Prussian *Landes Oekonomie Collegium*, and reported by the distinguished Magnus. The account of these experiments is given in detail in Erdman's *Journal für Praktische Chemie*, vol. xlviii.

Landes Oekonomie Collegium at that time carried on systematic experiments in agriculture at fourteen distinct stations scattered through the Prussian domain. The trials which we now speak of were made for the ostensible purpose of studying the exhaustion of the soil by cropping. The plan was to analyze the fourteen soils, the history of which for years previous was accurately known, then crop them with rape until "exhausted," then compare together the original composition of the soils with their composition after exhaustion, taking into account as well the composition of the crops removed. The research began with collecting and analyzing the soils. In order to meet, as far as possible, the difficulties of securing average specimens, equal portions of the soil of each field were taken with the spade at ten or twelve different points, and thoroughly intermixed; of each sample, three separate portions were analyzed, in most cases by different operators, who in many instances were the

most distinguished chemists of Germany. They were made according to a prescribed scheme, and, that there should be no reason to slight the work, the labor was paid for. It is true that analytical chemistry was not so advanced in 1846 as now. It is true that the methods then practised for estimating phosphoric acid and some other substances were not as perfect as they now are; but for the most part the analyses then made are as accurate as they could be executed to-day. It cannot be supposed for a moment that analysts like Rammelsberg, Genth, Knop, Varrentrap, etc. etc., would by fault of method or by carelessness return anything but results that were accurate, as far as it was possible to make them such.

A tabulation of the results, however, shows that the different determinations disagree to such an extent as to make it the sheerest folly to base any calculation of the value of the soil upon analysis. Some of the analyses agree sufficiently to show that accordant results are possible if uniform material be taken; but the grand result of the investigation is that the difficulties of getting a uniform material are exceedingly great. Again, we must remember that in the investigations in question, the three examinations of each soil were made upon portions of one carefully mixed sample. What would have been the result had each chemist received a sample collected separately from all the others, and from different parts of the field!

Again, the chemical analysis of soil reveals nothing as to its tenacity or lightness, its porosity or retentiveness for water, yet these physical and mechanical conditions, more than anything else, determine the adaptation of a soil for any particular crop. The best grass lands are not the best wheat lands; and although it would scarcely be questioned that wheat requires a richer soil than grass in order to produce an average crop, and although, as we know, it often happens that many successive hay crops may be removed from a meadow without sensible diminution of the yield, while uninterrupted cropping with wheat nearly always reduces the capacity of the soil in a very few years below a profitable point; yet each average hay crop removes from a field more of every ingredient of vegetation than the grain and straw together of an average harvest of wheat. Such at least is the testimony borne by the most recent and trustworthy data.

Twelve or thirteen years ago, Dr. Anderson, in his capacity of chemist to the Highland and Agricultural Society of Scotland, had occasion to investigate two soils which had become "clover-sick," and he caused them, together with similar adjacent soils which still produced clover, to be most minutely analyzed. Without reproducing his figures, which may be found in the *Trans. of the Highland and Ag. Soc.* for 1849–51, p. 204, we will merely quote some of the remarks which accompany the analyses: "The results of these analyses are certainly of an unexpected character, and appear to me to indicate that, in this instance, the failure of the clover cannot have been dependent upon the chemical constitution of the soil. In both cases the results of the analyses of each pair do not present a greater difference than would be obtained from the analyses of two portions of soil from different parts of any field."

Very recently, M. Stoeckhardt has published an account of several "clover-sick" soils from Schlanstaedt, which reveal to analysis a

greater content of *every nutritive mineral ingredient*, both soluble in water and in acids, than exists in another soil from Frankestein which produces clover and wheat as well. What proves beyond a doubt that the inability of these soils to yield clover depends upon something besides their chemical constitution, is the fact that lucerne and esparsette still flourish upon them admirably, and, further, clover itself, if sown with one of these last-mentioned crops, succeeds very well.

A great truth in agriculture is this: each kind of agricultural plant requires that its seeds be surrounded with certain conditions in order that they may germinate readily and healthfully, so that when the mother cotyledons are exhausted, the young plants shall attack the stores of food in the soil with that vigor which is needful in order to appropriate them without hindrance.

The fact that winter wheat is more delicate and fastidious in its infancy than most other crops, is perhaps the main reason why it does not succeed well on many good lands, and why it cannot be continuously produced from the same soil year after year. It is a matter of experience that wheat requires a rather firm seed-bed: beans, oats, and mangold-wurzel approach wheat in their requirements, while barley, peas, and turnips are best suited in a light tilth. On the other hand, climate, weather, and tillage so influence the character of the soil, that even on light lands wheat may find all the conditions of its growth. The bed which is produced by inverting a clover sod, and allowing it to be consolidated by time and rains, or by passing a heavy roller over it, is eminently adapted to wheat, even on a rather light soil.

The fact that, in the cases given above from Stoeckhardt, clover succeeded when sown with lucerne or esparsette, would indicate that possibly the condition of the seed-bed was the cause of failure.

These and other facts, which might be adduced to almost any extent, indicate sufficiently that chemical analysis alone, even if we admit its full nicety and accuracy, can at the best furnish us with a knowledge of but a few of many conditions which must coöperate in profitable agricultural production, and as a consequence its part in guiding the farmer is but very subordinate. Taking into the account its evident uncertainty and clumsiness when applied to estimating the minute quantities which affect vegetable growth, the part it can play becomes still more subordinate — we hesitate not to say, insignificant.

As we write, a fragment from a scientific journal brings to our notice a discovery which, if real, strengthens our views in an unexpected manner. It is well known that iodine is so immensely diluted in sea-water — the soil of marine plants — that none of our tests, though they are among the most delicate, serve to detect it directly, and it is doubtful if it has been detected even in the highly-concentrated mother liquors which remain after separating the crystallizable salts, yet the fuci find and accumulate it, and we must grant that it is present there for them, in sufficient quantity.

Again, Prince Salm Horstmar, several years since, in his admirable researches on the influence of the individual mineral ingredients of plants on the development of oats and barley, found that he could

not, by any possibility, exclude chlorine from his experimental plants. His soils and pots, the salts and water he fed his plants with, were so purified that he could not detect this element in them, and yet he invariably discovered it in the ashes of the plants. So, too, he found titanic acid in the produce grown on the most carefully purified soils. Now, it is mentioned in the *Chemical News* that he finds a *few hundredths of lithium are indispensable* to the ripening of barley. This element Bunsen has but recently shown to be everywhere distributed, yet it has hitherto been entirely unnoticed in all soil and plant analyses, because of its occurrence in almost infinitesimal quantity.

It must be well borne in mind that Agriculture herself — so-called Practice — is able of her own resources to judge somewhat of the value of soils, is able to know if a soil be fertile or poor, is able to pronounce upon its adaptation to crops, and can to a certain extent decide what is a good manure for this or that field.

We are free to assert that the knowledge which is now to be gathered from experience is able, in ninety-nine cases out of one hundred, to give a more truthful verdict as to the capacity of a soil than any amount of analysis, chemical, mechanical, or otherwise, can do. We would give more for the opinion of an old, intelligent farmer than for that of the most skilled chemist in most questions connected with farming. Doubtless the farmer would make some blunders from which chemistry might save him, but the chemist would be likely to do more violence to agriculture than the farmer would to chemistry.

By these statements, which may, but should not, surprise some of our scientific friends, we merely intend to express an opinion as to the present relative position towards agriculture of those who regard the art from a chemical, and those who see it from an experimental, point of view.

We have great faith that chemistry and that chemical analysis have done and are to do a work for agriculture that shall lay that venerable art under everlasting obligations to the youthful science; but not by soil analysis alone or mainly is this to be achieved. We do not assert that soil analysis is worthless; we believe that the probabilities of its uselessness in direct application to practice are so great that we could rarely base any operations on it alone, and yet it may in many cases promote science and give us data for conclusions that are of practical use. But for these purposes it must form part of a system of observations and trials, must be a step in some research, must stand not as the index to a barren fact, but as the revelator of fruitful ideas.

To study the soil in the hope of benefitting agriculture, we must regard all its relations to the plant. We must examine it not merely from those points of view which theoretical chemistry suggests, but especially from those which a knowledge of practical agriculture furnishes. This is becoming more and more the habit of agricultural chemists, and the results are of the happiest kind.

Let us remember what Boussingault has said as the summing up of his protracted experience and study: —

"At an epoch not far distant it was believed that a strict connection existed between the composition and the quality of arable soil.

Numerous analyses shortly modified this opinion as too positive. The sagacious Schübler even sought to prove, in a research that has become classic, that the fertility of a soil depends more upon its physical properties, its state of aggregation, power of absorption, etc., than upon its chemical constitution.

"The physical properties, in my opinion, do not enable us, more than the chemical composition, to pronounce upon the degree of fertility of the soil. To decide this point with some measure of certainty, it is indispensable to have recourse to direct observation; it is necessary to cultivate a plant in the soil, and ascertain with what vigor it develops there; the analysis of the plant afterward intervenes usefully, to indicate the kind and quantity of the elements that have been assimilated."

There has been much progress made in our knowledge of the soil during the last ten years. This advance has not consisted in revealing to us the presence of new elements, lithia perhaps excepted, nor in fixing with any more certainty the quantitative limits which separate barrenness from fertility; it has not shown what is the composition of a silurian or a sub-carboniferous, a drift, or a tertiary soil; it has not defined the soil adapted to wheat, or that productive of clover; it has not indicated the manures which this or that soil needs; but, content with the fact that all soils which naturally support vegetation contain the elements of vegetation, it has sought to ascertain in what forms these elements are assimilable, how they may be made available, what changes or reactions in the soil affect its productiveness, how fertilizers act indirectly (their influence often having no relation to any supposable direct action), how the soil affects the life of the plant otherwise than by feeding it, etc. etc.

We are approaching, in fact, by slow degrees, to an understanding of the physiological significance of the soil, — a grand result to which chemistry and physics coöperate.

GUANO.

We derive the following items respecting this important manure from an interesting paper recently presented to the French Academy of Sciences by M. Boussingault. The deposits of guano (*huano de pajoro*) extend from the 2d to the 21st degree south latitude along the coast of Peru. Those which lie beyond these limits are much poorer in ammoniacal compounds than the former, and are not, therefore, equal to them in value. Guano is generally found deposited on small promontories or on cliffs; it fills up crevices, and is in general to be found in those places where the birds seek shelter. The rocks of this part of the coast consist of granite, gneiss, syenite, and porphyritic syenite; the guano which covers them generally exists in horizontal layers; but sometimes the latter have a strong inclination, as at Chipana, for instance, where they are nearly vertical. The guano deposits are generally covered with an agglomeration of sand and saline substance, called *caliche*, which the laborers first remove before they begin their attacks on the guano. In some places, as at Pabellon de Pica and at Punta Grande, the deposits lie under a mass of sand descending from the neighboring mountain; and

on this subject an observation made by M. F. de Rivero is extremely curious. At the places above mentioned the lowest guano deposits are covered with a stratum of old alluvial soil; then comes another layer of guano, and then a stratum of modern alluvial soil. To understand the importance of this fact, our readers must keep in mind that the age of the modern alluvions does not extend beyond our historical times, while old alluvions date from the period immediately preceding that at which man first began to inhabit the earth; so that the guanaes, or cormorants and other allied tribes of birds which deposit guano, must have existed thousands of years before man, seeing that the inferior layer of guano is several yards, sometimes from fifteen to twenty, in depth, and the old alluvial crust above it has a thickness of three yards.

To explain the immense accumulation of guano in these regions, M. Boussingault observes that there has been a combination of a variety of causes favorable both to its production and preservation. Among these causes must be reckoned a dry climate, a ground presenting a vast number of chinks, fissures, and caverns, where the birds can rest, lay their eggs, and hatch them, without being disturbed by the strong breezes from the south; and then abundance of the food suited to them. Nowhere is fish so abundant as on this coast, where whole shoals of them are cast upon the shore even in fine weather. Antonio de Ulloa states that anchovies especially are in such abundance here as to defy description; and he gives a good account of the manner in which their numbers are diminished by the myriads of guanaes which are seen sometimes flying in countless flocks, like clouds intercepting the sun's rays, and sometimes darting into the sea to catch their prey. According to M. Boussingault's calculation, 100 kilogrammes of guano contain the nitrogen of 600 kilogrammes of sea-fish; and as the guano deposits, before they began to be worked, contained 378,000,000 of metrical quintals of guano, the birds must have consumed 2,268,000,000 of quintals of fish.

GUANO AND ARTIFICIAL PEARLS.

Artificial pearls were invented in the fifteenth century by a Parisian artist by the name of Jaquin. These are small beads of thin glass lined in the interior with *Essence d'Orient* and then filled with wax. But what is the substance called "essence d'orient?" This pompous name was invented for the sole purpose of concealing the true nature of the material from which it was prepared. But this material is furnished by a small white fish, the *ablette*, very common in the rivers of continental Europe. It accompanies the scales of this fish, and is detached when the scales are rubbed up for a considerable time and thrown into a vase of water. To collect the *essence d'orient* the water is poured off from the vase upon a fine hair sieve, which retains the scales and allows the water and the product sought to pass through it. The latter sinks to the bottom, and is obtained pure by decanting the water. A little ammonia is added to prevent its decomposition.

In one small river, in the department of Meurthe, not far from Nancy, they collect each year 25,000 kilogrammes of the *ablette*, pro-

ducing 600 kilogrammes of scales, worth 25,000 francs; and all this is employed exclusively in the preparation of artificial pearls.

Nothing is known concerning the chemical nature of this substance which is attached to the scales of this little fish, and no one appears to have devoted any attention to that point. Mr. Barreswil has, however, discovered that it is identical with a principle extracted directly from guano by Bodo Unger, which he called *Guanine.* Guano being an excrement of sea-birds, it follows on the one hand that the guanine might be met with in other species of fish besides the *ablette*, a thing which was to have been expected. Interesting in a physiological point of view is the question, what is this proximate principle which is not digested, and which is found unchanged in the excrements after they have been for many ages exposed to the action of the air? — *Silliman's Journal, Correspondence of M. Nickles.*

USES OF TEA IN THE HEALTHY SYSTEM.

In a paper recently read before the London Society of Arts, on the above subject, by Dr. Adam Smith, the author recommended the use of tea, as beneficial, in the following cases: after a full meal, when the system is oppressed with food; for the corpulent; for the old; for hot climates, and especially to those who, living there, eat freely, or drink milk or alcohol; in cases of suspended animation; for soldiers, who, in time of peace, take too much food in relation to the waste proceeding in the body; for soldiers and others marching in the heat of Eastern climates, — for then, by promoting evaporation and cooling the body, it prevents in a degree the effects of too much food, as of too great heat. For this purpose, a cold infusion may be made, and a quantity equal to twenty-five grains of tea should be taken often during exposure.

POISONING OF NOXIOUS ANIMALS.

On account of the numerous accidents which have occurred from using arsenic and phosphorus for this purpose, M. Sevérin Caussé, at the request of the French government, has been pursuing a series of investigations with the object of devising some means of poisoning which should be as efficacious and more safe than those in use. As general principles he lays down these rules: — 1. That we must not risk mistakes by employing the poison in the form of biscuits, pills, or powder. 2. An excipient must be used which is repugnant in taste to man but not to animals. 3. Emetic substances should be added, so as, in case of the poison being swallowed accidentally, vomiting may be produced, which is not with gnawing animals, like rats and mice. 4. The substance should be easily detectable by chemical analysis. 5. The composition he finally recommends, as best suited as a destructive agent, consists of tallow 886 grammes, tartar emetic 153 grammes, and euphorbium 51 grammes.

ARTIFICIAL ALIZARINE, THE COLORING PRINCIPLE OF MADDER.

At a late meeting of the Paris Academy, M. Dumas made the important announcement that M. Roussin, a French chemist, had suc-

ceeded in manufacturing from naphthaline (a product of the destructive distillation of coal) the substance known as alizarine, the coloring principle of the root madder, so extensively used in calico-printing. The process by which this result is effected was also made public, and is simple and inexpensive. The alizarine produced thus artificially has all the characteristics of the alizarine obtained from madder, and, like it, may be used as a dye-agent. The discovery is one which promises to be of great industrial value, and may lead to the abandonment of the cultivation of madder.

IODINE WATERS OF BAVARIA.

Perhaps there is no country in the world so rich in mineral springs containing iodine as Bavaria. The waters of Heilbrunn, the iodine spring of Salzbrunn, near Kempten, and the waters of Krankenheil, near Tölz, are known everywhere; and only a few months ago a new spring with the same ingredients has been discovered at the foot of the Bavarian Alps at Partenkirchen, near the Kanitz spring. According to the analysis of it just made by Professor Buchner, it is one of the strongest iodine waters which is known. If the water is acidulated with a few drops of nitric acid, and a solution of starch is then added, an intense blue color is immediately perceived; if it is then shaken together with sulphuretted carbon it becomes red, etc. The water of Heilbrunn, however, is still stronger than this one. The iodine is contained in this new spring as iodide of sodium, and, besides this, carbonate of soda and a considerable quantity of sulphuretted hydrogen are found in it; so that the water can also be used as a sulphur spring.

INTERESTING RESEARCHES ON FERMENTATION.

A very important and interesting result respecting *fermentation* has recently been presented to the French Academy by M. Pasteur. The various products formed during the so-called lactic acid fermentation are well known. Lactic acid, a gum mannite, butyric acid, alcohol, carbonic acid, and hydrogen, appear simultaneously or successively in extremely variable proportions, and very capriciously. M. Pasteur states that he has been slowly led to the recognition of the fact that the vegetable ferment which transforms sugar into lactic acid is different from that of those (for two exist) which determine the production of the gummy matter; and that the latter, in their turn, do not generate lactic acid. He has also ascertained that these several vegetable ferments cannot under any circumstances, if in a pure state, give rise to the formation of butyric acid. It follows, therefore, that a distinct butyric ferment must exist. After a long research the author has succeeded in detecting this body. *He finds that the butyric acid ferment is an infusorial animal.* The author for a long time took pains to remove and exclude these little animals, from the idea that they were feeding upon the vegetable substance which he supposed was the butyric ferment, and which he was seeking to detect in the liquid media he employed. But failing by that means to ascertain the cause of the origin of the butyric acid,

he began to perceive an inevitable coincidence between the infusorials and the production of this acid; a circumstance which he had previously attributed to the peculiar fitness of butyric acid to the life of these animalcules. After this observation, however, a great number of experiments convinced him that the transformation of sugar, of mannite, and of lactic acid, into butyric acid, was due exclusively to these infusorials; and that they must be regarded as the true butyric ferment.

M. Pasteur describes these animals as small cylindrical bodies, rounded at their extremities, generally straight, and connected together in chains of two, three, or four links each, sometimes more. Their length does not exceed the *fifteen thousandth part of a millimeter!* These diminutive creatures advance with a creeping motion, their body remaining nearly rigid, or at best experiencing but slight undulations. They are often bent at one or both of their extremities, but this seldom happens in their youth. They are fissiparous, that is, they multiply by separation, one link after another dropping off from the parent animal, and becoming a parent of others itself.

These infusorials may be grown or increased as we grow yeast of beer. They multiply themselves if the medium is appropriate to their nourishment. It is observed also that in a liquid only containing sugar, ammonia, and the phosphates, crystalline, so to say, mineral substances, they reproduce themselves correlatively to the butyric fermentation, which soon becomes very manifest. The weight of the amount formed is notable, although always small, compared to the total quantity of butyric acid produced.

The existence of infusorials possessing the character of ferments is a fact sufficiently worthy of attention; but it is accompanied in this case by a singular peculiarity. It is, that these animalcules live and multiply to infinity without being furnished with the least portion of air or free oxygen. M. Pasteur has demonstrated this curious fact by numerous experiments, which have proved satisfactory to those members of the Academy who witnessed them. But he goes further. He states that these infusorials not only live without air, but that air kills them. If a current of carbonic acid be passed through the liquid in which these animals are living and generating, they are not in the least affected; but if a current of air be substituted for the carbonic acid, they all perish within a couple of hours, and the butyric fermentation which depends on their existence is at the same time arrested. We obtain, therefore, this double proposition: 1st. The butyric ferment is an infusorial animal. 2d. This infusorial lives without free oxygen. This appears to be the first example of an animal ferment, and also of an animal living without oxygen.

PRODUCTION AND PREVENTION OF MALARIA.

At a recent meeting of the Manchester Literary and Philosophical Society, a paper was read by Dr. Angus Smith, "On the Production and Prevention of Malaria."

The author did not pretend to enter on the whole subject, but to give a few observations which he considered fitted for its illustration.

Malaria has unquestionably been proved to be caused by the decomposition of organized bodies. If so, it must exist to some extent everywhere. By the mode of testing the air invented by the author,[1] every place tried at home and abroad was found to have some oxidizable matter in it, although in some this was extremely small. In such cases the matter was probably oxidized to a state in which it would be innocuous. This oxidizable matter no doubt rises, in a great measure, from vegetation. Vegetation does not merely grow; it dies. This death may be caused by various circumstances, but two conditions are remarkable: one where the agents are animals, and the other where the agents are chemical. Animal life may act in various amounts on vegetation in the soil, from the large vermin to the microscopic classes. These do not prevent chemical action; on the contrary, it is probable that they further it exceedingly. Decomposition goes on in the soil at various rates, and in various ways. In a rich, highly-manured soil, kept warm, the soil will be found alkaline. Soils generally are acid. The author has shown, in a paper published in 1847, that in an alkaline, peaty district, cold weather produced acidity in a few days. It would appear as if the acids of the moulds (so elaborately described by Mulder) were incapable of further decomposition in the cold, and were thus retained and increased. Our great struggle with the soil is to produce alkalinity, or at least to diminish acidity, and where most acids exist we use most lime. Where most alkali exists there is a greater facility for the escape of vapors such as we suppose to be hurtful. So far as the vapors of putrid substances have been examined by the author, they have shown indications of containing substances composed somewhat like protein; at least their carbon and nitrogen have relations to each other similar or nearly identical with those found in protein.

The extreme condition of putrescence may be very readily produced in a soil by artificial means; the use of a little ammonia, for example, more than vegetation will bear. The substances putrefy until the whole becomes fetid in the highest degree. We have then a soil rich in organic matter and undrained. It is a swamp of the worst form if the soil be not very poor; worse, perhaps, than was ever seen in nature. Such a soil would bring death everywhere. It is artificial malaria. We can, then, produce malaria from the soil by fostering some of its tendencies; and we see by the rapid acidification of soil in colder weather why malaria is diminished by a lower temperature.

As we can imitate malaria of some kinds, so can we also imitate the methods by which nature prevents it. The warm alkaline soil, moistened, and washed with air and water, becomes acid; it sends forth less volatile matter; decomposition is stopped to a great extent; the matter is preserved. Cold prevents the action, drainage assists oxidation by a more active state of soil. By these modes and others the soil is disinfected by nature; when these do not act sufficiently, we may use disinfecting agents. By their means decomposition may be interrupted without fear of diminishing the power of the plant to

[1] See *Annual Sci. Dis.*, 1860, p. 239.

take up food. By the use of disinfecting agents, Mr. M'Dougall has been able to feed sheep and cattle, and retain them in health, on meadows constantly wet by irrigation with liquid manure. The disinfectant used is from the products of the distillation of tar; the amount required is small. Animal life is rapidly destroyed by it, and chemical decomposition is stayed. All climates can furnish this where coal lies or where trees grow.

It would be possible to irrigate great districts at a very small expense. The result would be as certain on a large scale as on a small one; and it is probable that, in some cases, one or two applications would be sufficient, for a long period at least. By the new state of things destructive insects would also be destroyed. This new method is especially applicable to other countries, and to more violent stages of the disease. The author hopes to have it tried on extensive districts in Italy. The method arose out of an advice everywhere neglected, but still cherished as true, to disinfect whole cities by beginning with the sewers, the origin and reservoir of all the mischief.

The author believes that he has shown that decomposition, to a most pernicious extent, is possible in soils; that this is not a mere opinion, but a fact readily demonstrated; but that decomposition may be arrested artificially to the preservation of health without the destruction of vegetation; and that in these facts we have not only a surer basis in our reasonings on the origin of malaria, but an almost certain process for its ultimate and total extermination.

Cause of Malaria. — The well-known chemist, Boussingault, recently presented a paper to the French Academy, in which he stated that carbonic oxide is developed in connection with oxygen whenever the sun shines upon vegetable matter submerged in water impregnated with carbonic acid. The presence of so deleterious a gas as carbonic oxide in the atmosphere of marshy countries, as manifested by this discovery, might, he thought, give a clue to the origin of the diseases which are prevalent in districts exposed to marshy exhalations.

CHEMICAL AND PHYSICAL MODIFICATIONS OF THE ATMOSPHERE CONSEQUENT ON HABITATION.

The repeated observations of chemists have taught us to regard the identity of composition of the atmosphere as a fixed law, one to which no exception is to be found in nature, unless it be in the neighborhood of tropical rivers, where vast quantities of organic matter, the *débris* of a luxuriant vegetation, are rapidly passing into decomposition. Everywhere, whether collected on the top of Mont Blanc, on the banks of the Seine or Thames, or in the middle of the Atlantic, the two main constituents of the atmosphere are found in precisely the same proportion, and the more perfect the processes of analysis have become, the firmer has the constancy of this relation been established. This fact has always, however, been rebelled against by the common experience of mankind; it has been almost an opprobrium to science that, in spite of the manifestly different *feeling* of the air on the Swiss mountains and in the middle of London, the chemist can detect no difference in composition. During

the last few years, several chemists have directed their attention to this apparent inconsistency between the organoleptic and physical characters of the air with special reference to the condition of the atmosphere in towns. These researches have related mainly to the quantity of carbonic acid, and other products of combustion, and to the existence of organic matter in suspension. Among the most important are those of Dr. Dundas Thomson and Dr. Angus Smith.

The percentage of carbonic acid usually existing in the air of London was found by Dr. Roscoe to be 0.037 per volume, a result not differing materially from those obtained by Dumas and Boussingault in Paris. The analyses on which these are based were made by passing a known volume of air over weighed tubes containing alternately pumice-stone steeped in sulphuric acid and potash, a method which leaves nothing to be desired in respect of accuracy. Dr. Smith's estimations of the carbonic acid of the air of Manchester, made by the same method, give somewhat higher results. He found that on a windy day they averaged from .08 per cent. to .45 per cent., and that on a still day the percentage amounted to .12. When, however, we consider that, although London is the greatest city in the world, Manchester is the largest manufacturing town, and that it is the centre of a manufacturing district comprehending many hundred square miles, over which an atmosphere darkened by smoke perpetually hangs, we are not surprised to find that the products of combustion exist in larger proportion than in London or Paris. Dr. Smith has calculated, from the quantity of coal burnt in the neighborhood of Manchester, that 15,000 tons of carbonic acid must be introduced into the atmosphere daily, without taking into account the quantity expired by man and animals.

A much more important product of combustion is derived from the oxidation of the sulphur contained in coal, and the introduction thereby into the atmosphere of sulphurous and sulphuric acids. In the researches undertaken by Dr. Thomas during the last epidemic of cholera, which consisted in passing large quantities of the air of London through distilled water, it was found that such air invariably possessed an acid reaction, and that this reaction was due to sulphuric acid. Dr. Smith has further investigated this question, and has found that in Manchester the acid reaction of the atmosphere is much more constant and intense than in London. Blue litmus paper becomes red in half an hour, and sometimes in ten minutes, when exposed to Manchester rain, and occasionally its acidity is such that a single drop is sufficient to effect the reaction. The actual quantity, however, is exceedingly small; of a solution containing a thousandth part of its weight of carbonate of soda, quantities varying from ten to fifty grains suffice to neutralize one thousand grains of such rain, and as much cistern water is found to be neutralized by twenty-five grains; from which results Dr. Smith concludes that the largest quantity of sulphur acids existing in the atmosphere of the town does not exceed 0.004 per cent. by weight, a proportion amounting to not more than a twentieth part of the carbonic acid. As to the share of sulphurous and sulphuric acids respectively in this total, it is of course impossible to arrive at a conclusion; but considering what we know of the rapidity with which the former is oxidized in the air, it

is to be supposed that whenever the acidity of the atmosphere is marked, it will be mainly owing to the latter. The impregnation of the rain with a mineral acid must be regarded as rather beneficial to health than otherwise, as tending to retard the putrefaction of animal matter on which it falls.

Dr. Dundas Thomson appears to have been among the first to recognize the importance of *organic matter* as a constituent of the air of towns, and to express the conviction that the gaseous products evolved during putrefaction are not the main sources of danger. Proceeding on this idea, he subjected a large quantity of atmospheric air to chemical investigation, "with a view of condensing any vapor, or detaining solid particles, which might be disseminated." The result was entirely negative. Further inquiries of the same kind were made, under the sanction of the Board of Health, in 1854, the air being passed, as has been already mentioned, through distilled water, the result invariably being that fungi made their appearance in the water, and in a short time, by their rapid growth, pervaded the whole of it, so as to be evident to the unassisted eye. It was also found that by passing the air through sulphuric acid in the same manner, the acid became soon dark colored, in consequence of the charring of the organic matter introduced into it. Dr. A. Smith has worked out the idea much more completely. He has preferred a chemical to a microscopical test for the detection of the suspended organic matter. It consists, as most of our readers may be aware, in passing the air through a very dilute solution of permanganate of potash, the strength of which is determined by ascertaining how much is required to decompose a solution of a weighed quantity of oxalic acid, or of uncrystallized sugar. This test obviously indicates not the quantity of organic matter, but the quantity of oxidizable matter, in the atmosphere, and hence it is only valuable in so far as we may assume that the atmosphere contains no reducing agent. Thus, in the presence of sulphurous acid, it would be of little value were it not that that agent exists, even in the town air, in exceedingly small quantity. Many of Dr. Smith's results are of such a nature as to be beyond the possible limits of this source of error. It was found that the same quantity of the solution of permanganate which was decolorized by one bottle of air obtained in a close court in Manchester, required twenty-two bottles to decolorize it on the hills in the neighborhood. Assuming that sugar and the organic matter of the air are decomposed by the same amount of manganate, "a supposition which cannot be perfectly true, but which, from the minuteness of the amounts, leaves no room for a great error," Dr. Smith concludes that whereas, on the high grounds north of Manchester, there existed but one grain of organic matter in 200,000 cubic inches, in close places in the town there was a grain in 8000 cubic inches. From his most recent observations he concludes that we have "in different air breathed by people in the same country a substance the amount of which in one case is twenty-two times greater than in the other, and in air breathed by people in the same town a difference which is as nine to twenty-two."

The whole importance of these investigations, regarded from the point of view of preventive medicine, lies in their relation to the

putrefactive process. To discover a means of seizing upon and estimating putrid exhalations — under which term we include everything not gaseous that is disengaged into the atmosphere from the surface of living animals, no less than the exhalations from dead animal matter — would be certainly a most important step towards acquiring a more satisfactory knowledge of the influence of habitation on health. We have, therefore, to inquire what grounds there are for regarding Dr. Smith's test, or any other founded on a similar reaction, as affording a solution of this problem. It is not difficult to satisfy ourselves that animal matter in putrefaction does disengage from its surface portions of its substance of sufficient tenuity to be suspended in the atmosphere. Without referring to offensive smells, which of course must be material, we have several satisfactory proofs. If a bell-glass be inverted over decomposing animal matter, in a moist condition, the inner surface of the glass becomes in a few days bedewed with moisture, which, on being examined under the microscope, is found to contain the same filamentous fungi to which reference has already been made, and on evaporation it leaves a residue, which is blackened by incineration. Similarly we find that the moisture which is deposited in glutinous drops on the sides and arched roofs of sewers is rich in organic matter, which must clearly have been derived from the air of the sewer. Dr. Smith has related the results of experiments showing that air kept for a length of time in contact with putrescent matter becomes loaded with oxidizable material, and acquires the power of decomposing a correspondingly large quantity of permanganate of potash.

Another group of facts shows us that the existence of putrescent impurity in the air is a principal, though not a necessary, condition of the induction of putrefaction in bodies susceptible of the change. Thus, for example, I have found that milk which has retained its freshness for hours will at once turn on being exposed to a putrid emanation. Butchers are familiar with the fact that meat cannot be successfully dressed in the neighborhood of a stinking gully grate, or of a stable reeking with ammonia; and for the same reason every intelligent butcher keeps his slaughter-house in a state of scrupulous cleanliness. It is not, however, to be forgotten that other causes, possibly electrical, the nature of which is still involved in obscurity, have a still greater influence in inducing putrefaction. Thus, in this country, the butcher finds that on one day he is able to slaughter and dress even veal or lamb with safety; whereas, on another, not differing in temperature, incipient putrefaction may render the carcass unsalable, in spite of the most careful precautions; butchers are apt to believe that this occurs mostly on calm days when the air feels heavy. Still more remarkable are the facts recorded respecting the slaughtering of cattle in hot countries; the operation can only be safely performed when the air is clear and the sky cloudless. Under such circumstances, we are told that the appearance on the distant horizon of a cloud "like a man's hand," the sure precursor of a storm, is a sign to the slaughterers on the Pampas of South America to desist from their work, for it is immediately followed by rapid putrefaction.

Air contaminated with putrescent matter is for the most part al-

kaline. Thus, the air of sewers is invariably so, as has been proved by the experiments of Dr. Dundas Thomson, its alkalinity being owing partly to ammonia, partly to the sulphuret of ammonium, the form assumed by the sulphur disengaged in the decomposition of fæcal matter. The air of stables and stable dwellings is strongly alkaline, as every one in attendance on the sick poor in London well knows; and the air expired by men and animals, although at first probably acid, rapidly becomes alkaline by putrefaction. The relation between putrefaction and the existence of ammonia in the air is therefore so close that the detection of this body may, under ordinary circumstances, be regarded as a proof of its existence.

Bleaching Power of the Air. — It is known to those who are commercially engaged in air-bleaching, that the bleaching power of the air varies very considerably, not only according to the season and time of day, but irrespectively of such periods. It has not yet been determined what is the relation between this reaction and the oxidizing power of the air, as exhibited in its power of decomposing iodide of potassium. But the remarkable experiments of M. Houzeau, made simultaneously in town and country, have shown that country air bleaches much more rapidly than town air, and that in this respect the difference is no less marked than in that of the well-known ozone reaction, which has been so clearly shown to be destroyed by urban contaminations.

The pressure, temperature, and moisture of the air are but little modified by habitation. The readings of the barometer and hygrometer in town and country do not differ. There is, however, one respect in which the temperature of great towns may be favorably compared with that of the country, viz., in that of equability.

Mr. Glaisher found that in the middle of London the night temperature is much higher, and the day temperature considerably lower, than in the country, and consequently that the range of daily temperature is nearly twice as great in the country as in London, especially in clear weather, when the cloudless sky of the country contrasts with the smoky obscurity of town. This immunity from great variations of temperature must tend to diminish, though probably it does not at all counterbalance, the generally injurious effects of town air on persons affected with chronic pulmonary disease.

In the preceding paragraphs we have reviewed all the differences which are discoverable either by physical or chemical means between the atmosphere of towns and that of the country; and we are in a better position to determine in the light of physiology which of these conditions is likely to exercise most influence on the health of man. As regards the existence of an excess of carbonic acid, it is clearly of no importance whatever, for in many large towns no such excess is met with. Sulphurous and sulphuric acids, if they have any influence, must act as "colytics," *i. e.*, as agents tending to arrest putrefactive change. The absence of sunlight, on which the more equable temperature of towns depends, has unquestionably an unfavorable influence, but one which is very limited. We are driven then to the only difference which remains, viz., that which depends on the existence of oxidizable matter, as indicated by its power of reducing certain metallic oxides. — *Br. and Foreign Med. Review.*

ACTION OF POROUS BODIES IN INDUCING CHEMICAL COMBINATIONS.

M. B. Corenwinda showed some years ago that partial combination of sulphur and hydrogen may be effected by bringing the two bodies together in the presence of pumice-stone at a red heat. He has recently shown that the vapor of water may be also decomposed by sulphur, when some porous body, at an elevated temperature, is made to intervene. The experiment was conducted as follows: some fragments of recently calcined pumice-stone were placed in the middle part of a glass or porcelain tube; one end of the tube was then filled with pieces of sulphur, a plugget of asbestos being placed between the cork and the sulphur. A tube, by which steam could be sent in, passed through the cork. The pumice-stone was then heated to redness and the sulphur made to slowly volatilize; at the same time a current of steam was cautiously sent through. After a little time sulphuretted hydrogen was produced in abundance. A still more decided result is obtained if pure calcined silica be substituted for the pumice-stone. The porous body is totally unacted upon in all cases.

The author directs the attention of geologists to these results; he thinks that they may explain the presence of sulphuretted hydrogen in certain volcanic emanations.—*London Pharm. Jour.*

CHEMICAL MANUFACTURES.

From a report to the British Association (1861) on the chemical manufactures of Lancashire and Manchester, England, we derive the following particulars:—

In the manufacture of sulphuric acid, most of the manufacturers use iron pyrites as a source of sulphur, rather than imported crude sulphur. The use of platina stills for the rectification of sulphuric acid has now been almost entirely abandoned, and their place supplied by glass retorts, which are made larger and of better quality than formerly.

The weekly production of sulphuric acid of specific gravity 1.85, in South Lancashire and Manchester, exclusive of what is used in the manufacture of soda ash, is seven hundred tons, or one million four hundred thousand pounds.

No changes have taken place in the process of manufacturing soda during the last ten years, the essential points of the original method of Leblanc (1798) being still adhered to. The extent of the manufacture has largely increased since the year 1851. The value of alkali made annually in England is two million pounds. The price of oxalic acid, used extensively in calico printing, woollen and silk dyeing, has been reduced by the introduction of a new process for its manufacture, since 1851, from fifteen to sixteen pence per pound to eight or nine pence per pound. The quantity of oxalic acid manufactured at one establishment in Manchester is nine tons (eighteen thousand pounds) per week.

The quantity of dye-woods (logwood, fustic, etc.) consumed weekly in the arts in South Lancashire and Manchester amounts to

between six and seven hundred tons; of madder, one hundred and fifty tons are used weekly.

The manufacture of disinfectants has also of late become a regular and constant business in England. At an establishment of Mr. McDougal, at Oldham, England, a disinfecting powder is prepared in which the properties of carbolic and sulphuric acid are taken advantage of. This is used to prevent decomposition in stables, cow-houses, and among accumulations of putrescible matter, and generally for the prevention of decomposition in manures. A liquid is also prepared with carbolic acid and lime-water, which is applied for the purpose of preventing decomposition in sewers, according to the idea of purifying whole cities by preventing the generation of gases in sewer water or among accumulations of animal refuse. The liquid is also used to prevent the decomposition of animal matter when it cannot at once be made use of, especially in the case of meat brought to the market, or animals that have died in the field. The solution of the powder has also been used to some extent in dissecting-rooms, where it immediately destroys any noxious smell, and at once liberates the fingers of the operator from the peculiarly nauseous odor which so often attaches to them. It has also been found useful in the treatment of sores, as well as of dysentery. Mr. McDougal has also applied carbolic acid with great advantage to the destruction of parasitic insects on sheep and other animals.

ECONOMICAL USES OF WATER-GLASS (SILICATE OF POTASSA OR SODA.)

Mr. J. M. Ordway, in the September number of *Silliman's Journal*, 1861, furnishes a comprehensive article on the history, preparation, and industrial applications of so-called "water" or "soluble" glass, a silicate of potassa or soda.

In regard to the adhesiveness of this substance, Mr. Ordway states that it has been called a "mineral glue," but that it differs from glue, and most other cementing substances, in continuing to shrink after it has become apparently dry. A strong silicate of soda solution forms a good colorless cement for glass, porcelain, and stone, but when shut up in such impervious substances it is very slow in becoming water-proof, and as it does so, its strength is much impaired. For wood and other porous materials it does not answer, since they allow the access of air, which, by its carbonic acid, decomposes the silicate and destroys its tenacity. I have tried silicate of soda in the laboratory for pasting labels on glass bottles. It does pretty well, only when it is once on it will never wash off, though the paper itself may be removed by washing. It possesses no advantages over gum or flour paste, with the single exception of not being liable to mould by keeping.

When liquid water-glass, either by itself or mixed with an inert substance, is thinly spread out on any surface, it dries to a strongly adherent, hard, transparent varnish; but it still goes on absorbing carbonic acid from the air, and the residual silica, being quite incapable of extension, becomes traversed with an infinity of minute cracks, so that the original smoothness and clearness are greatly diminished.

Still the adhesion continues, and the silicious coating can no longer be removed by washing with water. Hence the soluble silicates are adapted to fix various pigments. In fact this was the first use to which they were made subservient, and they have of late been much employed in Europe for painting. When water-glass mixed with the lighter colors is applied to wood, the alkaline nature of the vehicle betrays itself by a softening and discoloration of the surface, which effects, however, are quite inconsiderable, if the wood is new and clean. Another difficulty is, that the fixed coating, having no elasticity, cannot accommodate itself, like an oily or resinous film, to the expansions and contractions of the wood in wet and dry weather, nor yet to slight inequalities of shrinkage. Still, water-glass paint may do well in places where it is not exposed to alternations of dampness and dryness.

Silicate paint is most suitable for stone, brick, or mortar surfaces, which are unyielding. The best way of applying the silicate of soda as a paint is to put it on in several thin coats, and allow several days to elapse between each application. There are several paints with which it is unfit for mixing, such as white lead and Prussian blue, but zinc white, chalk, yellow ochre, sulphate of baryta, cadmium yellow, venetian red, green oxide of chrome, umber, lampblack, and ultramarine will mix with it and make good paint. These colors should be ground up with the water-glass, and before applying them the surface to be painted should receive a primary coat of pure silicate twenty-four hours before the paint is put on. A good silicate of soda should be bright and transparent. A great deal of that which has been sold has been mixed with foreign substances and was unfit for painting purposes.

Walls plastered with lime-mortar may be rendered very hard, close, and smooth, as well as capable of being washed, by applying a few times a silicate, either alone or mixed with chalk or any coloring material.

A mixture of water-glass and peroxide of manganese is recommended to be applied to cooking-stoves when they are red-hot, as it is said to make a good blacking, not as liable to burn off as common black lead.

The binding power of the silicates has been turned to account by Kuhlmann in the hardening or "silicatization" of soft porous stone. A tender material, like chalk, may be rendered available for building purposes by repeated saturations with water-glass. And the durability of many buildings already erected is greatly enhanced by subjecting the outside surface to a similar treatment. The same process has been found efficacious in preserving some ancient statues freshly exhumed, which would otherwise have fallen to pieces after a short exposure to the air. Fragile palæontological specimens have also been strengthened and saved by silicatization.

Ransome says that merely washing stone with water-glass is not sufficient, as the silicate retains its solubility for a long time. He therefore thought fit to secure a patent for fixing the silica by the subsequent application of chlorid of calcium. But, notwithstanding the strong commendations of interested parties, it would appear from recent discussions of the subject in London that this method has not

proved entirely satisfactory. Indeed, hasty fixation can hardly be compatible with tenacity and permanence, and it is probable that the best effect would be attained by using a silicate alone, many times, and at distant intervals.

With regard to stone, silicatization is of little importance in this country, as we have few varieties that need artificial hardening. But in some places there is a lack of good clay for brick-making, and such earth as is worked gives very tender, absorbent brick, ill calculated to bear handling and exposure to the weather. In many cases it would doubtless be advantageous to silicatize the exposed surface of the bricks after they have been laid. This is deserving of especial consideration where they are subjected to the action of sea-water, which is particularly destructive of porous building materials.

Wagenmann succeeded in making artificial meerschaum by mixing water-glass, lime, magnesia, and carbonate of magnesia, and simply drying.

Considered merely with regard to its mechanical properties, water-glass would appear very suitable to replace starch and glue as a glazing material, in many cases. In fact it was brought forward by Leigh, a year or two ago, as a substitute for starch in sizing cotton-yarn for weaving, and in putting the final finish on cotton fabrics. But its chemical character indicates its unfitness for such uses. Starch, after drying, remains unchanged itself, and has no action on the stuffs; while a silicate is altered by exposure to the air, and loses its smoothness as well as much of its rigidity. Besides this, it is alkaline, and therefore tends to weaken the fibre, an effect which becomes at once apparent when water-glass is used strong for producing very stiff fabrics.

Silicate of soda, on account of its chemical relations, has come into general use as a substitute for phosphate or arseniate of soda in dunging printed calicoes. This, the most important of all the applications, was patented in England by Jäger in 1852, and it has now almost entirely superseded other dunging materials.

PRESERVATION OF STONE BY THE PROCESS OF SILICIFICATION.

The difficulty which besets many of the processes of silicification is, that along with the needful silica so much superfluous, and indeed injurious, matter is introduced that the valuable qualities of the silica are in a great measure counteracted, the disintegration of the stone being sometimes actually caused by the efflorescence of these extraneous substances; the porous character necessarily induced as the consequence of the gradual removal of the soluble salts in juxtaposition with the silica almost undoing the binding and hardening action of this valuable material. Silica can, however, be obtained in the form of pure aqueous solution in several ways:—

1. By dissolving sulphide of silicium in water, when sulphuretted hydrogen is given off, and the silica remains completely dissolved, and in such quantity that the liquid gelatinizes when an attempt is made to evaporate it.

2. By precipitating silica in the gelatinous state from an alkaline

silicate, by means of acetic or other weak acid, and, after well washing, heating it for some time under pressure, with a small quantity of water in a closed vessel. A liquid is thus obtained which gelatinizes on addition of a saline solution.

3. By passing gaseous fluoride of silicium over crystallized boracic acid, and separating the hydrofluoric and boracic acids by digestion with a large excess of ammonia, a hydrate of silica remains, which, when well washed from the above acids, is very soluble in water. This solution gives no precipitate when boiled, but leaves silica as an insoluble powder on evaporation.

4. By the beautiful method recently pointed out by Professor Graham, in which advantage is taken of the new means of separating bodies by *dialysis*. A solution of silicate of soda, supersaturated with hydrochloric acid, is placed on one side of a parchment paper septum, pure water being on the other side; in a few days the hydrochloric acid and chloride of sodium will be found to have completely passed through the diaphragm, leaving the silica in aqueous solution, and so pure that acid nitrate of silver fails to detect chloride in the liquid. This solution remains liquid for some days, but it ultimately gelatinizes. We have generally adopted this last plan of preparing the aqueous solution of silica, although a stronger solution is obtained by the method first given.

When a pure aqueous solution of silicic acid prepared as above is allowed to soak into the pores of chalk or dolomite, a process of hardening rapidly occurs, which goes on increasing for several days, whilst, owing to its considerable depth of penetration, and to there being no soluble or efflorescent compounds to be removed, there is every probability that this hard silicious impregnation will afford permanent protection to the stone.—*London Chem. News.*

GEOLOGY.

RECENT PROGRESS OF GEOLOGY.

The following is an abstract of an address delivered before the Geological section of the British Association, 1861, by Sir R. I. Murchison; the subject being mainly a retrospect of the progress attained to during the last twenty years in our knowledge of the geology of the older rocks. In the commencement, alluding to the recent investigations respecting the antiquity of the human race, Mr. Murchison said: —

Having carefully examined the detrital accumulations forming the ancient banks of the river Somme, in France, I am as complete a believer in the commixture in that ancient alluvium of the works of man with the reliquiæ of extinct animals as their meritorious discoverer, Perthes, or as their expounders, Prestwich, Lyell, and others. I may, however, express my gratification in learning that England, in several localities, is also affording proofs of similar intermixture.

In regard to the main additions which have been made since 1842 to our knowledge of the older rocks in the British Isles, the following statements, commencing the retrospect with the older rocks, may, said Mr. Murchison, be regarded as substantially true.

The stratified gneiss of the north-west of Scotland, and of the outer Hebrides, *is the fundamental rock of the British Islands, and the precise equivalent of the Laurentian system of Canada.* The establishment of this order is of great importance, as it gives to geology a lower doctrine-line than was previously possessed. For hitherto the order of the geological succession, as approved by De la Beche, Phillips, Ramsay, Jukes, and others, admits no older sediment than the Cambrian of North Wales.

The researches in the Highlands of Scotland have, however, shown that in the British Islands the older palæozoic rocks, properly so called, or those in which the first traces of life have been discovered, do repose, as in the broad regions of the Laurentian Mountains of Canada, upon a grand stratified crystalline foundation, in which both limestone and iron ores occur subordinate to gneiss. In Scotland, therefore, these earliest gneissic accumulations are now to be marked on our maps by the Greek letter *alpha*, as preceding the Roman *a*,

which has been previously applied to the lowest known deposits of England, Wales, and Ireland. Though we must not dogmatize and affirm that these fundamental deposits were in the pristine state absolutely unfurnished with any living things (for Logan and Hunt, in Canada, have suggested that there they indicate traces of the former life), we may conclude, that in the highly metamorphosed condition in which they are now presented to us in North-western Britain, and associated as they are with much granite and hornblendic matter, they are, for all purposes of the practical geologist, "azoic rocks." The Cambrian rocks, or second stage in the ascending order, as seen reposing on the fundamental gneiss of the north-west of Scotland, are purple and red sandstones and conglomerates forming lofty mountains.

They have afforded some few traces of organic life: the "Oldhalmia," possibly an Alga; some worn tracks, and the trace of an obscure crustacean.

The Highland rocks of this age, as well as their equivalents, the Huronian rocks of North America, have as yet afforded no trace whatever of former life. And yet, such Cambrian rocks are in parts of Wales, and especially in the lofty mountains of the north-western Highlands, much less metamorphosed than many of the crystalline rocks which lie upon them. Rising in the scale of successive deposits, we find a corresponding rise in the signs of former life on reaching that stage in the earlier slaty and schistose rocks in which animal remains begin clearly to show themselves. Thus, the Primordial Zone of Mr. Barrande is the oldest fauna of his Silurian Basin in Bohemia.

In the classification adopted by De la Beche and his associates, the Lingula Flags (the equivalent of the "Zone Primordial" of Barrande) are similarly placed at the base of the Silurian System. This Primordial Zone is also classed as the Lowest Silurian by De Verneuil, in Spain; by Dale, Owen, and others, in the United States; and by Sir W. E. Logan, Sterry Hunt, and Billings, in Canada.

In the last year Mr. Barrande has most ably compared the North American Taconic group of Emmons with his own primordial Silurian fauna of Bohemia, and other parts of Europe; and it is quite evident that the primordial fauna occurs in many parts of North America. And as the true order of succession has been ascertained, we now know that the Taconic group is of the same age as the lower Wisconsin beds described by Dale Owen, with their Paradoxides, Dikelocephalus, etc., as well as of the lower portion of the Quebec rocks, with their Conocephalus, Axionellus, etc., described by Logan and Billings. Of the crystalline schists of Massachusetts, containing the noble specimen of Paradoxides described by W. B. Rogers, and of the Vermont beds, with their Oleni, it follows that the Primordial Silurian Zone of Barrande (the lower Lingula flags of Britain) is largely represented in North America, however it may occupy an inverted position in some cases, and in others be altered into crystalline rocks.

In an able review of this subject, Mr. T. Sterry Hunt thus expresses himself: "We regard the whole Quebec group, with its

underlying primordial shales, as the greatly-developed representatives of the Potsdam and Calciferous groups (with part of that of the Chazy), and the true base of the Silurian system." "The Quebec group, with its underlying shales," this author adds, "is no other than the Taconic system of Emmons;" which is thus shown to be the natural base of the Silurian rocks in America, as Barrande and De Verneuil have proved it to be on the continent of Europe.

I take this opportunity of reiterating the opinion I have expressed in my work, *Siluria*, that to whatever extent the primordial zone of Barrande be distinguished by peculiar fossils in any given tract from the prevalent Lower Silurian types, there exists no valid ground for differing from Barrande, De Verneuil, Logan, and others, by separating this rudimentary fauna from that of the great Silurian series of life of which stratigraphically it constitutes the conformable base. And if in Europe but few genera be yet found which are common to this lower zone and the overlying formation, we may not unreasonably attribute the circumstance to the fact that the primordial zone of no country contains more than a very limited number of distinct forms. May we not, therefore, infer that in the sequel other fossil links, similar to those which are now known to connect the Lower and Upper Silurian series, — which I myself at one time supposed to be sharply separated by their organic remains, — will be brought to light, and will then zoologically connect the primordial zone with the overlying strata into which it graduates? Let us recollect that a few years only have elapsed since M. de Verneuil was criticized for inserting in his table of the Palæozoic Fauna of North America a number of species as being common to the Upper and Lower Silurian. But now the view of the eminent French academician has been completely sustained by the discovery in the strata of Anticosti, British America, of a group of fossils intermediate in character between those of the Hudson River and Clinton formations, or, in other words, between Lower and Upper Silurian rocks.

On the continent of Europe an interesting addition has been made to our acquaintance with the fauna of one of the older beds of the Lower Silurian rocks, or the Obolus green-sand of St. Petersburg, by Ehrenberg. He has described and figured four genera and ten species of microscopic Pteropods. It is well to remark that, as the very grains of this Lower Silurian green-sand seem to be in great part made up of these minute organisms, so we recognize, in one of the oldest strata in which animal life has been detected, organisms of the same nature as, and not less abundant than, those which constitute the deep sea-bottoms of the existing Mediterranean and other seas.

Before I quit the consideration of the older palæozoic rocks, I must remind you that it is through the discovery by Mr. Peach of certain fossils of Lower Silurian age in the limestones of Sutherland, Scotland, combined with the order of the strata, observed in the year 1827 by Professor Sedgwick and myself, that the true age of the largest and overlying masses of the crystalline rocks of the Highlands has been fixed. The fossils of the Sutherland limestone are not indeed strictly those of the Lower Silurian of England and Wales, but are analogous to those of the calciferous sand-rock of

North America. The Maclurea is indeed known in the Silurian limestone of the south of Scotland; but the Ophileta and other forms are not found until we reach the horizon of North America. Now, these fossils refer the zone of the Highland limestone and associated quartz-rocks to that portion of the lower Silurian which forms the natural base of the Trenton series of North America, or the lower part of the Llandeilo formation of Britain. The intermediate formation — the Lingula flags or "zone primordiale" of Bohemia — having no representative in the north-western Highlands, there is necessarily a complete unconformity between the fossil-bearing crystalline limestone and quartz-rocks with the Maclurea, Murchisonia, Orphiléta, Orthis, Orthoceratites, etc., and those Cambrian rocks on which they rest.

A great revolution in the ideas of many an old geologist, including myself, has thus been effected. Strengthened and confirmed as my view has been by the concordant testimony of Ramsay, Harkness, Geikie, James, and others, I have had no hesitation in considering a very large portion of the crystalline strata of the Highlands to be of the same age as some of the older fossiliferous Silurian rocks, whether in the form of slates in Wales, of graywacke-schist in the southern counties of Scotland, or in the conditions of mud and sand at St. Petersburg. Many years ago, I suggested, after examination, that some of the crystalline rocks near Christiana, in Norway, were but altered extensions of the Silurian deposits of that region; and since then the truth of the suggestion has been demonstrated. We all know, furthermore, that in North America all noted geologists, however they may differ on certain details, agree in recognizing the fact that the vast eastern seaboard range of gneissic and micaceous schists is made up of metamorphosed strata, superior even to the lowest of the Silurian rocks. In regard, however, to the *modus operandi* by which whole regions of sedimentary deposits have been converted into crystalline slates and schists, we are far from having satisfied our minds. The Rev. W. Harcourt, after a series of trials to illustrate the phenomena of the metamorphism of rocks by experiments carried on in iron furnaces, has arrived at the same conclusion at which, in common with Sedgwick, Buckland, De la Beche, Phillips, and others in my own country, and with L. Von Buch, Elie de Beaumont, and a host of geologists abroad, I had long ago arrived in the field. I, therefore, re-echo their voices in repeating the words of Mr. W. Harcourt, "that we are not entitled to presume that the forces which have operated on the earth's crust have always been the same." Looking to the only rational theory which has ever been propounded to account for the great changes in the crust which have taken place in former periods, — the existence of an intense central heat, which has been secularly more and more repressed by the accumulation of sediment, until the surface of the planet was brought into its present comparatively quiescent condition, — Mr. Harcourt has indicated the train of causes, chemical and physical, which resolve some of the difficulties of the problem.

Illustrating his views by reference to chemical changes in the rocks and minerals of our own country, and fortifying his induction by an appeal to his experiments, he arrives at the conclusion that

there existed in former periods a much greater intensity of causation than that which now prevails. His theory is, that whereas now, in the formation of beds, the aqueous action predominates, and the igneous is only represented by a few solfataras, in the most ancient times the action was much more igneous, and that in the intermediate times fire and water divided the empire between them. In a word, he concludes with the expression of the opinion, which my long-continued observation of facts had led me to adopt, "that the nature, force, and progress of the past condition of the earth cannot be *measured* by its existing condition."

In addition to these observations on metamorphism, let me remind you that, on the recommendation of the British Association, other important researches have been carried on by Mr. William Hopkins, and in the furnaces of Mr. Fairbairn, on the conductive powers for heat in various mineral substances. Although these experiments have been retarded by a serious accident which befel Mr. Hopkins, they are still in progress, and I learn from him that, without entering into any general discussion as to the probable thickness of the crust of our planet, we may even now affirm, on experimental evidence, that, assuming the observed terrestrial temperature to be due to central heat, the thickness of this crust must be two or three times as great as that which has been usually considered to be indicated by the observed increase of temperature at accessible depths beneath the earth's surface.

Of the Devonian rocks, or old red sandstone, much might be said if I were to advert to the details which have been recently worked out in Scotland and in England; but confining myself to general observations, it may be stated, that a triple subdivision of that group, which I have shown to hold good over the continent of Europe, as in our own country, seems now to be generally admitted.

Very considerable advances have been made in the development of the Carboniferous system. The close researches of Mr. Binney, who has from time to time thrown new lights on the origin and relations of coal, and the component parts of its matrix, established proofs, so long ago as 1840, that great part of our coal-fields was accumulated under marine conditions; the fossils associated with the coal-beds being, not, as had been too generally supposed, of fluviatile or lacustrine character, but the spoils of marine life. Professor Henry D. Rogers came to the same conclusion with regard to the Appalachian coal-fields in America, in 1842. Mr. Binney believes that the plant Sigillaria grew in salt water, and it is to be remarked that even in the so-called "fresh-water limestones" of Ardwick and Le Botwood the Spirorbis and other marine shells are frequent, whilst many of the shells termed Cypris may prove to be species of Cytherea. Again, in the illustrations of the fossils which occur in the bands of iron ore in the South Welsh coal-field, Mr. Salter, entering particularly into this question, has shown that in the so-called "Unio-beds" there constantly occurs a shell related to the Mya of our coasts, which he terms Anthracomya; whilst, as he stated in the *Memoirs of the Geological Survey*, just issued, the very Unios of these beds have a peculiar aspect, differing much from that of true fresh-water forms. They have, he said, a strongly-wrinkled epidermis,

which is a mark of the Myadæ, or such burrowing bivalve shells, and not of the true Unionidæ; they also differ in the interior. Seeing that in these cases quietly deposited limestones with marine shells (some of them indeed of estuary character) rest upon beds of coal, and that in many other cases purely marine limestones alternate frequently with layers of vegetable matter and coal, may we not be led to modify the theory, founded on the sound observation of Sir W. E. Logan, by which the formation of coal has been rather too exclusively referred to terrestrial and fresh-water conditions? May we not rather revert to that more expansive doctrine, which I have long supported, that different operations of nature have brought about the consolidation and alteration of vegetable matter into coal? In other words, that in one tract the coal has been formed by the subsidence *in situ* of vast breadths of former jungles and forests; in another, by the transport of vegetable materials into marine estuaries; in a third case, as in Russia and Scotland, where purely marine limestones alternate with coal, by a succession of oscillations between jungles and the sea; and, lastly, by the extensive growth of large plants in shallow seas.

The geological map of Edinburghshire, prepared by Messrs. Howel and Geikie, and recently published, affords indeed the clearest proofs of the frequent alternations of beds of purely marine limestone charged with Producti and bands of coal, and is in direct analogy with the coal-fields of the Donetz, in Southern Russia.

Concerning the Permian Rocks which were formed towards the close of the long palæozoic era, and constitute a natural series of the old Carboniferous deposits, it has recently been shown that they present in little England nearly as great diversities of lithological structure as those which distinguish the strata of the same age in Eastern Russia in Europe from the original types of the group in Saxony and other parts of Germany.

Sir R. I. Murchison further stated that, from recent geological researches, it would appear that in the southern hemisphere there is not merely a close analogy between the rocks of the Palæozoic age and our own, but, further, as far as the Mesozoic formations have been developed, they also seem to be equivalents of English typical Secondary deposits.

This existence of groups of animals during the Silurian, Devonian, Carboniferous, and even in Mesozoic periods, in Australia and New Zealand, similar to those which characterize these formations in Europe, is strongly in contrast with the state of nature which began to prevail in the younger Tertiary period. We know, from the writings of Owen, that at that time the great continent at our antipodes was already characterized by the presence of those marsupial forms which still distinguish its *fauna* from that of any other part of the world.

GEOLOGY OF THE COUNTRY BETWEEN LAKE SUPERIOR AND THE PACIFIC.

At a recent meeting of the London Geological Society, Mr. James Hector communicated a paper giving the geological results of three years' explorations of the British territories in North America along

the frontier line of the United States, and westward from Lake Superior to the Pacific Ocean.

It began by showing that the central portion of North America is a great triangular plateau, bounded by the Rocky Mountains, Alleghanies, and Laurentian axis, stretching from Canada to the Arctic Ocean, and divided into two slopes by a water-shed that nearly follows the political boundary line, and throws the drainage to the Gulf of Mexico and the Arctic Ocean. The northern part of this plateau has a slope, from the Rocky Mountains to the eastern or Laurentian axis, of six feet in the mile, but is broken by steppes, which exhibit lines of ancient denudation at three different levels: the lowest is of fresh-water origin; the next belongs to the drift-deposits; and the highest is the great prairie-level of undenuded Cretaceous strata. This plateau has once been complete to the eastern axis, but is now incomplete along its eastern edge, the soft strata having been removed in the region of Lake Winnipeg.

The eastern axis sends off a spur that encircles the west shore of Lake Superior, and is composed of metamorphic rocks and granite, of the Laurentian series. To the west of this follows a belt where the floor of the plateau is exposed, consisting of Lower Silurian and Devonian rocks. On these rest cretaceous strata, which prevail all the way to the Rocky Mountains, overlaid here and there by detached tertiary basins.

The Rocky Mountains are composed of carboniferous and Devonian limestones, with massive quartzites and conglomerates, followed to the west by a granitic tract, which occupies the bottom of the great valley between the Rocky and the Cascade Mountains. The Cascade chain is volcanic, but the volcanoes are now inactive; to the west of it, along the Pacific coast, cretaceous and tertiary strata prevail. The description of these rocks was given with considerable detail, on account of their containing a lignite which for the first time has been determined to be of cretaceous age. This lignite, which is of very superior quality, has been worked for some years past by the Hudson Bay Company, and is in great demand for the steam navy of the Pacific station, and for the manufacture of gas. Extensive lignite deposits in the prairie were also alluded to; and, like those above mentioned, were considered to be of cretaceous age; but, besides these, there are also lignites of the Tertiary period.

CHANGES OF CLIMATE INDUCED BY CHANGES IN THE EARTH'S AXIS.

The following letter has been addressed to the *London Athenæum* by Professor Airy, the British Astronomer Royal, in answer to the speculations of Sir Henry James (see *Annual of Scientific Discovery*, 1861, p. 287), Chief of the Ordnance Survey of Great Britain: —

"On the possibility of a great change in the terrestrial position of the earth's axis of rotation having been produced by the elevation of mountain masses," Mr. Airy says, "I do not question the accuracy of the principle of Sir Henry James's speculations; but I very greatly doubt the adequacy, in magnitude, of the cause to explain the supposed effects.

"To begin with the case most favorable for the production of a large effect, I will suppose the earth to be a perfectly rigid spheroid, which has, in distant ages, and under proper circumstances, assumed the form of equilibrium, and whose axis of rotation coincides with its axis of figure, and is a principal axis. And I will suppose a mountain mass to be elevated by something like a gaseous explosion (the hollow being filled up by the influx of neighboring matter), in latitude not very different from 45°; it is evident that such elevation, either at the pole or at the equator, will not disturb the parallelism of the axis of rotation.

"As the mountain mass partook of the rotatory movement before its elevation, its elevation will not disturb, in any material degree, the velocity of rotation. The principal effect of the elevation is, that the axis of rotation is no longer a principal axis, that the principal axis of largest moment is now a little way beyond the present axis of rotation, and the two other principal axes, whose moments formerly were equal, now have moments very slightly different. The effects which follow are scarcely affected by this last modification.

"It is well known that under these circumstances the axis of rotation will wander in the solid earth. But it will not wander indefinitely; its pole will describe on the earth's surface an ellipse not sensibly different from a circle, whose centre is the pole of the new principal axis, and after a certain time it will return to its former position. The greatest change, therefore, in the terrestrial position of the earth's pole will be double the distance of the new principal axis from the former principal axis.

"A very slight investigation suffices to show that the angular change of the position of the principal axis will depend upon the proportion which the moment of inertia of the mountain mass (or rather the increased moment of inertia from all the changes in its neighborhood, some being elevations and some depressions) bears to the excess of the moment of inertia round the polar axis above the moment of inertia round an equatorial axis. This latter excess is about half the moment of inertia of the equatorial protuberance, that is, half the moment of inertia of a mass of matter twenty-five thousand miles long, six thousand miles broad, and thirteen miles deep. And what mountain mass can compare sensibly with this? Even if a mountain mass contained one-thousandth part of this matter (which I apprehend is very far above the fact), the shift of the earth's pole would be only two or three miles; and this, though it would greatly surprise astronomers, and might sensibly affect the depth of waters in harbors, would produce no such changes of climate as those which it is desired to explain.

"Now, let us suppose that the earth is not absolutely rigid, but that there is susceptibility to change of form, either from that degree of yielding or fracture to which most solid substances are liable, or from the hydrostatic pressure of internal fluid. This, as I conceive, puts an end to all supposition of change of axis. The first day's whirl would again make the axis of rotation to be a principal axis, and the position of the axis is then permanent.

"The density of the sea is so much less than that of the solid parts of the earth, that it is not very important for us to consider it; but,

as far as it has any influence, it is evident that it would immediately receive that change of form to which I have adverted.

"When the position of the axis of rotation within the earth is sensibly permanent, its position, excluding the effects of external actions, is also sensibly permanent in the heavens.

"So far, therefore, as I am at present able to enter into the question, I entirely doubt the validity of the cause assigned by Sir Henry James for the changes of the earth's climates."

Mr. W. E. Hicksen, also entering the lists as a disputant on the same subject, writes as follows:—

The sun, in its apparent motion, makes a complete tour of the zodiac in a period usually estimated at 25,868 years,—shortened by some later authorities to about 21,000 years,—called the Precessional Cycle; the cause of which is not any real change in the position of the sun, but a change in the position of the observer, from an altered inclination of the earth's axis.

If an observer were to place himself, on the 21st of March, at the bottom of a dry well, or at the lower end of any long shaft, like that of the inclined passage of the Great Pyramid, and look upwards, he would see, at any given hour, certain stars cross his field of view; and he would again see the same stars next year on the same day, but not at precisely the same moment. They would cross his field of view some seconds earlier; and earlier again, and continually earlier, every successive year; proving, not that the stars had moved, but that the sidereal bearings of the earth had changed. In confirmation of which, if your readers turn to *Vyse's Pyramids*, they will find a calculation of Sir John Herschel's, that the entrance front of the Great Pyramid must, in the year B.C. 2123, have looked towards *α Draconis*, instead of towards our present polar star, *α Ursa Minoris*.

This varying direction of the earth's axis is occasioned by the varying influence of the sun and moon on the protuberant matter of the earth's equator, in necessary correspondence with the earth's variations of distance in different parts of its orbit; and in respect of which varying influence the earth may be described, if I may use a homely figure, as in the situation of a man held by the collar between two policemen, and swayed to the right or left according to the force exerted by policeman A or policeman B. The monthly swayings to and fro of the earth's axis, which are very slight, thus arising, are called Nutation; the annual balance of their aggregate result is called the Precession of the Equinoxes; the meaning of which is, that the equinoxes arrive earlier and earlier every year, and with them, of course, spring and summer, autumn and winter.

Sir Henry James will have rendered a service to science if he succeeds in inducing geologists to inquire into the effects of this periodical evagation, the laws and limits of which are known; but, until they have done so, it would perhaps be wise to defer raising the question, for which we have no astronomical data, of whether or not the axis of the earth was "at one time perpendicular to the plane of the ecliptic." The certain effects of precession in producing changes of climate and modifications of the earth's crust are sufficiently striking to detain us, without at present going further.

One consequence is, that the summers of unequal length, which

prevail in the northern and southern hemispheres, from the elliptical form of the earth's orbit, are periodically transferred by precession from one hemisphere to the other, so that, by an alternate increase and diminution of heat and cold, the frigid zones of each hemisphere are alternately contracted and enlarged in breadth. Thus, during the full course of a precessional cycle, say of twenty-four thousand years, there will occur an extreme variation of tropical latitudes equal to 47°, or of from 23½° north to 23½° south; sufficient to have once brought the true line of the tropics within 5° of the southern coast of England.

Another consequence is, a periodical shifting of the beds of the oceans, from the law which allows fluids more readily than solids to follow the slightest impulse of a new centre of gravity, and from the alternate congealing and liquefying of unequal quantities of water in the Arctic and Antartic Seas; and a third consequence is, a periodical dislocation of strata from an addition to, or release from, superincumbent pressure whenever the waters of the oceans find new beds and channels: a cause alone sufficient to account for the upheaving of mountain chains.

A general conclusion from the same premises may be drawn, that, from the slow but continuous displacement of the fluids and solids of the globe in progress, the protuberant matter of the equator must be insensibly forming and reforming itself of fresh materials, so that in the lapse of infinite ages every pebble on the earth's surface may take its turn of exposure to tropical and arctic influences, without any further change in the direction of the earth's axis than the precessional change described, and without any alteration in the spheroidal form of the earth's mass.

PHYSICAL GEOGRAPHY OF THE RED SEA.

The following is condensed from a paper recently read by Dr. Buist to the Bombay Geographical Society, and from remarks appended to it: —

The length of the Red Sea from the Straits to Suez is 1,230 miles; the greater strait is 13 miles wide, and the lesser 1½ mile. Its entire circuit measured round both gulfs is 4,020 miles; its area, 108,154 miles, and its cubical contents probably 800,000 miles. Its greatest breadth, under parallel 17° north, is 192 miles, and it narrows toward both extremities. Two-thirds of the Red Sea had never been sounded when this paper was written, and the greatest depth tried was at lat. 25° 20′, where no bottom was found at four hundred fathoms. The Gulf of Aden, which continues the communication from the Straits to the Arabian Sea, is a funnel-shaped estuary, above nine hundred miles in length, and nearly two hundred across from the north-west point of Africa to the Arabian shore.

The name, Red Sea, is derived from large portions being covered with patches, from a few yards to some miles square, composed of microscopic vegetables, or animalculæ, particularly abundant in spring, and which dye the water an intense blood-red. When not affected by these organic beings, the deep waters are intensely blue, and the shoal waters shades of green. Contrary to expectation, the

water is not remarkably salt, the saline matter varying from 39.2 to 41 grains in 1000; the water at Havre yielding 36 in 1000, and at Marseilles 38, while at the Canaries it reaches 44. Dr. Buist estimates that the evaporation from the Red Sea is equal to eight feet annually, and that not more than one inch of rain, or rain-water, is added in the same time, as, although there are heavy rains on the shores, they are sucked up by the parched sand. He considers that the result of the enormous evaporation is to produce a constant descent of heavy salt water to the bottom of the sea; and when this heavy fluid rises to the level of the Mocha barrier, he thinks it falls over in an outward current, and is replaced by an upper inflowing current. In this manner he thinks the whole of the water is changed once a year. Just within the Straits is a fearfully hot portion of the sea, the highest temperature prevailing between 14° and 21° N., which is the great volcanic region. There the sea rarely falls lower than 80° even in the winter months. In March and April it mounts to 84°; by May it occasionally reaches 90°. The greatest heat is in September, when sea and air get occasionally above blood heat, and looking over the rails of the ship when the sea is in this state, and rain falls and cools the deck, the feeling is that of holding the head over a boiling cauldron. In November, 1856, when the air was 82°, the sea rose to 106° between lat. 17° and 23°; but this was an exceptional case.

OBSERVATIONS ON SPITZBERGEN.

The following are some of the principal results attained to by the recent scientific expedition, dispatched during the past year, by the Swedish government, to the polar islands of Spitzbergen and vicinity: —

And, first, it has been ascertained beyond a doubt that the Gulf Stream impinges on the Spitzbergen coast. Not only was the seed of the *Mimosa scandens* discovered there, but also quantities of glass bottles, which the inhabitants of the Lofoden Islands and of Finmarken use in their cod-fisheries, as floats for their nets. It may, therefore, be inferred that this branch is a continuation of that which touches the Norwegian coast. The drift timber, however, which is found in large quantities along the coast, is carried thither by a stream from the east, namely, the Siberian, as a quantity of birch-bark, rolled together in a peculiar form, and evidently manufactured by man, was found amongst it, and it is known that the tribes along the Siberian coast use this birch-bark for net-floats. The pumice-stone which was found in large quantities on the coast in all probability comes from Iceland, the southern coast of which is washed by a branch of the Gulf Stream. The Gulf Stream, however, was found to exert no influence on the marine animal life, which is entirely of a glacial nature; but that it does have great influence on the temperature and climate, there can be no question.

Formerly it was supposed that the limit of eternal snow reached down nearly to the surface of the sea in the northern part of Spitzbergen; but from observations made on a range of rounded and uniform mountains, devoid of projecting points, etc., it was ascertained that this limit is at least one thousand Swedish feet above the level

of the sea; so that there can be no glacier formation at a lower altitude.

Another experiment of much interest was also made with reference to the temperature of the sea at great depths. It had been the opinion that at great depths in the Arctic Ocean the temperature was at least $+2°$ Cent.; but by using the apparatus termed the M'Clintock apparatus, a compact mass of bottom clay was brought up from a depth of 2,800 yards; and a thermometer being thrust in to a depth of two inches from the surface of the lump, showed 0.6° Cent., while in the centre it showed 0.3°, the temperature of the water on the surface being 4.°; and though the decreasing temperature of the clay might have been affected by the increasing temperature of the water as it was being hauled up from the bottom, — a business of two and a half hours, — still it can have had no possible influence on the centre. At all events, therefore, the temperature of the bottom was by this experiment proved to be not less than 0.3° Cent.! Notwithstanding this low degree of warmth, there were found several marine animals of different types and classes, amongst others a moderately large Polyparium, probably belonging to the Hydroid class; a bivalved mussel, some Tunicata attached to the Polyparium, Annelides, and one Crustacean of bright colors.

The flora in Spitzbergen is poor; but still the expedition has collected about sixty species of Phanerogamous plants. A white bear that was shot was, on being opened, found to have its stomach full of plants, thus proving that these animals can be herbivorous.

An interesting observation that was made led the naturalists of the expedition to the inference that the tusks of the walrus, among other uses, are employed to *dig up food from the bottom;* for in the stomach of one of the specimens was found a quantity of the *Mya truncata*, a species of sand-mussel, which lies buried at least one foot below the surface of the mud, and which the walrus, therefore, could only reach by using its tusks like a dung-fork, with which to turn up the mud from the bottom.

Of land birds a few only were found: the Falco, Gerfalco, Stryx nyctea, Ptarmigan, and Snow-bunting. As far as can be recollected there were no strand birds, except the *Tringa maritima.* Eider-ducks were found, both kinds of Auks, and Gulls in plenty. The sea around Spitzbergen is very poor in fish; but marine animals of a low type were numerous; and among these will probably be found much that is new. Of geological specimens an interesting and valuable collection has been made. The palæontological formations seem to belong to the Permian and Jura. Numerous fossils were collected, amongst which were ammonites, and impressions of leaves of Dicotyledonous genera, bearing a strong resemblance to palm-leaves.

UNITY OF GEOLOGICAL PHENOMENA IN THE SOLAR SYSTEM.

The following ingenious and plausible article, by L. Sæmann, is translated from the *Bull. de la Soc. Geologique de France*, Feb., 1861, for *Silliman's Journal*, by T. Sterry Hunt, F. R. S.: —

The observations upon the solar eclipse of July 18, 1860, have given rise among astronomers and physicists to some interesting dis-

cussions upon the nature of the sun, which seem to merit the attention of geologists. The opinion hitherto generally adopted is founded upon the view suggested by Arago from his observations concerning the spots upon the sun. This great astronomer conceived that by admitting a dark nucleus surrounded by a luminous atmosphere or photosphere, it would be easy to explain the luminous phenomena presented by the sun. On the other hand, Leverrier, from the observations made in Algiers by the scientific commission from the Paris Observatory, maintains that the sun is luminous from the incandescence of its nucleus, and that the variations in the intensity of the light at its surface may be explained by atmospheric perturbations similar to those of our own atmosphere. M. Leverrier is led to admit for the sun at least two atmospheres, different in nature and in density, and it is principally with regard to the external envelope, or rose-colored atmosphere, which gives rise to the flames or luminous protuberances, that there exists a difference of opinion among observers.

Other observations of a very different nature give a strong support to the conclusions of Leverrier; the remarkable discoveries of Kirchhoff and Bunsen upon the dark lines in the solar spectrum have enabled us to submit the solar atmosphere to an optical analysis, which makes known its chemical composition, and shows it to contain several alkali-metals, including sodium and calcium, which can only exist there in the state of gas or vapor. The discussion of this interesting subject belongs especially to chemists and physicists, but geologists may be permitted to express their sympathy for that view which accords the best with the theory that forms the basis of their science, and is, moreover, entitled to a certain authority among mathematicians and astronomers, inasmuch as it bears the name of the illustrious Laplace.

All modern geological theories implicitly admit the unity of our planetary system, in so far as that they suppose the sun, the planets and their satellites to have been formed from one primitive substance; their very variable densities only show that the constituent elements are grouped in varying proportions. It is not necessary to suppose that each body of the system presents exactly the same chemical combinations as are known on our globe, for affinities will vary with the temperature and the densities of the elements, but we may admit that a portion of any one of these celestial bodies, brought to the surface of our earth and there subjected to terrestrial influences, would, in obedience to the chemical affinities which here prevail, be at length converted into *a portion of earth.*

This unity of origin once admitted, there is no longer any reason for denying the analogy if not the identity of the phenomena which have accompanied the formation of the sun and the planets, at least of those whose density approaches the nearest to that of the earth. All of them must have passed by cooling from a state of igneous fluidity to a solid condition, and their present state will depend upon the greater or less facility which their volume and their composition will have offered to the passage of heat. The chemical composition being the same, the duration of the geological epochs upon each planet will have been nearly in a direct ratio to its volume, setting aside certain corrections, of which it is not necessary at present to discuss the

elements. The low density of the sun, which is little greater than that of water (0.252 that of the earth), would lead us to suppose the existence there of a peculiar condition of things; science has, however, as yet no means of appreciating the action of a heat so excessive as that which is required to maintain the alkali-metals in a gaseous state, and it appears possible that if the temperature of the sun were reduced to that of the earth, its density would also be approximated to that of our planet. However this may be, the analogies of Leverrier's theory with the observations of geologists are too important, as showing the connection between the two great branches of natural science, not to encourage geologists to further inquiry in the same direction, and it is with this object in view that we have been led to the following reflections.

We admit a similar geological or chemical constitution for the various bodies of the solar system, and from this conclude that the phenomena which have accompanied their formation and their successive transformations must have been similar. Thus the planets and satellites whose density is near to that of our earth may be supposed to have passed through the different stages of liquid and solid incandescence, of the successive liquefaction of portions of their gaseous envelopes, and to have finally been the seat of an organic creation.

Of these planetary bodies the best known to us is the moon; and we shall now inquire to what extent our slight knowledge of it is in accordance with the observations made on our earth, and with the present state of the sun as supposed by M. Leverrier. It is well known that astronomers, so soon as they became possessed of good telescopes, discovered mountains and plains, or seas, on the surface of the moon, and the immediate application of these names shows the great resemblance which was supposed to exist between the surfaces of the moon and the earth. It does not appear surprising that the form of the lunar mountains should be met with among only a small number of those on our planet, and physicists easily explain the greater elevation and the steep declivities of the former by the comparatively feeble action of the centripetal force at the moon's surface. But one of the gravest objections to the idea of a common origin of the moon and the earth is the apparent absence of water and air from the surface of our satellite, thus seriously embarrassing those geologists who attribute terrestrial volcanic phenomena to the intervention of these expansible elements.

If, however, we admit for the earth and the moon an identical and simultaneous point of departure, we can understand that their cooling has taken place at a rate nearly proportioned to their volume. That of the moon being about two hundredths the volume of the earth, its temperature, if we admit an equal conductibility, will have decreased with a rapidity fifty times greater, so that the geological epochs of the moon will have been in the same proportion shorter than the corresponding epochs on the earth, up to the time when the solar heat began to be an appreciable element. The moon has then advanced much more rapidly than the earth in the series of phenomena through which both must pass, and we may therefore logically suppose that our globe will one day offer the same general characters as are now presented by the moon.

We believe, then, that the water which covers the surface of the earth, and the air which surrounds it, will one day disappear, as a necessary consequence of the complete cooling of the interior of our planet. Rocks, with few exceptions, readily absorb moisture, and the more crystalline varieties are the most porous; we need not, however, consider the quantity of water which rocks may imbibe in this way, for the total amount of this element on the earth's surface is so small, when compared with the whole mass of the globe, that the ordinary processes of chemical analysis would not detect its presence. If we take the mean depth of the ocean at 600 meters,[1] =1968 feet, its weight will be equal to one twenty-four-thousandth of the earth, which, being reduced to decimals, would give for one hundred parts,

Earth, ...	99.9958
Water, ...	.0042

In the Bulletin of the Geological Society of France (2d series, vol. x. p. 131), Durocher has published a series of experiments made to determine the quantity of water in those minerals which enter into the structure of rocks, such as the feldspars, micas, hornblende and pyroxene, and which are regarded as anhydrous in composition. These minerals were reduced to coarse powder and exposed to moist air, the proportion of water being determined both before and after. It will be sufficient for our purpose to give the amount of water found after exposure. The orthoclase of Utoë absorbed in this way 0.41 for 100 parts, while the mean of seven other varieties of the same species was 1.28, and that of thirty specimens of various substances 1.27. We have already seen that if the whole of the ocean were to be equally distributed throughout the earth this would contain only 0.0042, or one hundred times less than the least hygrometric of the feldspars. It is probable that the water of the ocean thus absorbed would enter into chemical combination; at all events, it would occupy a space much less than the pores produced by the shrinking of the rocks.

If, now, we attempt a similar calculation for the atmosphere, we find that in supposing a height of eight kilometers, the total volume of the air which surrounds our globe, brought to the density which it has at the surface, would be about four millions of cubic myriameters, the volume of the earth being equal to 1083 millions, or 270 times that of the air, so that a contraction of the primitive volume producing a vacuum of four thousandths ($\frac{1}{250}$) would be more than sufficient to absorb the whole of the atmosphere. (In calculating the volume of the atmosphere we have multiplied the surface of the globe, in square myriameters, by 0.8, which gives a sufficiently accurate result, the more so that the density of the air in the interior of the earth will be everywhere greater than at the surface.)

It now remains to be seen whether the assumption of a shrinking of four thousandths can be justified by analogies. In the want of di-

[1] This depth is deduced from the comparison of the relative areas of land and water, which are taken as 1 : 3, the elevation and depression of the surface being assumed as proportional to the square roots of their surfaces. The depth of the Pacific Ocean, as deduced by Bache from the earthquake wave of Dec. 1854, was about 13,000 feet.

rect determinations of the porosity of crystalline rocks, upon which subject I am not aware of any published experiments, the observations upon the fusion of rocks, and the determinations of their densities in the crystalline and vitreous states, admit of an indirect application to the question before us. The experiments of Charles Ste. Claire Deville, in the *Comptes Rendus* for 1845, and of Delesse in the *Bulletin* for 1847, agree so closely in this matter that we give them the preference over those of Bischoff, published in 1842. Deville and Delesse found that the fusion of rocks yields glasses whose density is generally inferior to that of the rock in the crystalline state. This diminution for granite is equal to from nine to eleven hundredths, and it is evident that such a glass, passing to a crystalline state and retaining its volume, must present vacant spaces in direct proportion to the augmentation of density, that is to say, equal to about one-tenth of its volume. If we take the mean density of granite at 2.60, it might with such a degree of porosity imbibe 3.9 parts in 100.0 of its weight of water. This shrinking of one-tenth is no exaggeration, and such a rock would still be a good building material, although containing twenty-five times more vacant space than our calculation requires.

The vitreous state of a body is nothing more than a fixing of its molecules in the positions which belong to them in the liquid state, and probably represents the liquid in its greatest degree of density. The crystallization of barley sugar, of wrought iron, and of Reaumur's porcelain, are striking examples of the tendency of molecules to group themselves in crystals even in the midst of solid masses, and we can thus readily understand the absence of vitreous substances among the older crystalline rocks. The great difficulty is to determine with exactness the proportion of the vacant spaces resulting from this change, since these will vary for each body, and probably also with the volume of the mass. Sulphur fused in an open vessel crystallizes slowly, the level of the liquid sinks a little, and after complete solidification the surface is covered with hollows resulting from the shrinking, whereas if cooled in a spherical shape these cavities would naturally be formed at the centre. Water and bismuth, as is well known, behave in a very different and remarkable manner, the first dilating eight or ten hundredths at the moment of congelation, and the second one fifty-third. The only conclusion to be drawn from these facts is, that each body in solidification behaves in a different manner, and that for the solution of the question before us we can only take into account the well-known porosity of rocks. The problem, however, appears to me one of great importance in connection with theoretical geology; if we admit with Deville that at the moment of crystallization the density of rocks is in all cases augmented, we are forced to conclude that all the crystalline masses formed at the surface of the liquid globe must have sunk and accumulated at the centre. The effect of a similar action has been shown by physicists, who have demonstrated that the cold of winter would freeze our lakes and rivers from the bottom if the ice sunk at the moment of its formation, as would the solidified parts of a lake of molten sulphur. We should then have, in place of a liquid globe surrounded by a solid shell, a mass solidified to the centre; a conclu-

sion which is perhaps more in harmony with the feeble and local action which the interior is known to exert on the surface. Since, then, the data are wanting to fix the amount of shrinking in the crystallization of rocks, we may find in an analogous phenomenon some terms of comparison. The difference between the density of cast metals and the same after hammering can only arise from a contraction similar to that which takes place in igneous rocks. The surface becoming solid while the interior is yet liquid, the natural contraction of this portion is prevented, and from this necessarily result vacant spaces in the mass, which are afterwards compressed by the action of the hammer. In calculating from the differences in density the volume of the vacant spaces thus produced, we find for iron a contraction of 0.075; for nickel, 0.045; for aluminum, 0.041; for copper, 0.011; for gold, 0.005; while the contraction of the earth necessary to absorb the whole atmosphere would be only 0.004. From this it results that an ingot of gold, the most solid obtained by the fusion of a metal, contains more vacant space in proportion to its volume than would be required in the globe for the absorption of its gaseous envelope; it is scarcely possible that any crystalline rock should be wanting in this slight degree of porosity.

From the preceding considerations, the successive absorption of the air and water by the solid portions of the globe becomes in the highest degree probable, and we may conclude that our earth will one day present that same total absence of ocean and atmosphere which we now remark in the moon. It is evident that this progress of the waters towards the earth's centre must have long been in operation, and it becomes interesting to consider the effect which this must have had upon the level of the ocean. Let us suppose that the rocks near to the surface of the earth contain one hundredth of water, a proportion which, from the above calculation, will not be regarded as excessive, and that the water moreover does not exist in this proportion at a depth beyond that at which the terrestrial heat equals 100° Centigrade. If we take the augmentation of heat in descending to be one degree for thirty-three meters, this will give a depth of about 3,000 meters, while one part of water by weight in one hundred parts of a rock whose density is equal to 2.5, will correspond to a volume of one-fortieth. We shall now calculate the volume of this external layer which we have supposed to be thus impregnated with water, regarding it as a prism having for its base the surface of the earth, with a height of 3,000 meters, which would give a mass of 1,530,000 cubic myriameters, containing 38,000 cubic myriameters of water. The total volume of the ocean being one forty-eight thousandth that of the globe, or 225,000 cubic myriameters, it follows that this layer of 3,000 meters of earth would contain a volume of water equal to one-sixth of the present ocean. Whatever may be the real value of these figures which we have adopted to render the demonstration more clear, the interest and importance of this inquiry is evident.

I am convinced that the ultimate complete cooling of the interior of the earth is inevitable. We may affirm on general principles that between two media of different temperatures, separated by a layer of rock which is a conductor of heat, an equilibrium will at length be

established. It is probable that this cooling is, however, to a great extent effected by the innumerable currents of water and gases which circulate in every direction through the interior of the globe, and of which volcanic eruptions, hot springs, and *suffioni* are only the more violent manifestations attaining the earth's surface. The recent ingenious experiment of Daubrée has shown us that water may be drawn by capillary force towards spaces heated much above its boiling point. The water thus conveyed, in passing into the state of vapor, does not everywhere produce volcanic phenomena, for these probably require the concurrence of conditions which are not often found. The aqueous vapor will ordinarily ascend to colder portions of the earth's crust, and there, yielding its heat to the walls of the fissures, will flow back in the liquid state to the source of heat to repeat the same process, while on the other hand currents of cold water will absorb the heat thus conveyed to the rocks and bring it to the surface by thermal springs.

The general permeability of rocks is so well admitted by most geologists that I have not thought it necessary to seek for proof of it in the discussions of the present question; the brilliant conception of the metamorphism of rocks by the humid way, which has been so well maintained by the ablest chemists, is only possible on this condition. The permeability of rocks also explains in a satisfactory manner the formation of agates, and of zeolites, arragonite, and other minerals in the midst of the most compact basalts, and of geodes of quartz, in the Norwegian granites. We may also recall the artificial colors which are given to agates. Mr. Damour has even shown by a series of curious experiments that the water which is ordinarily considered as chemically combined in certain hydrated silicates, such as zeolites, may be in part extracted from them, and again restored, without any apparent alteration in these minerals.

NOTE. *Depth of the Ocean.*—In the above article, Mr. Sæmann has quoted Laplace's inference of 600 meters (near 2000 feet) for the mean depth of the ocean. All researches tend to show that this depth is very greatly less than the actual depth; the data on which Laplace's conclusion was based are also quite conjectural. The area of land to sea is now stated as 3 : 8, and not, as formerly, 1 : 3. This would render the ocean even shallower than was stated by Laplace; while every modern observation in deep soundings, and above all the discussion of waves of translation in earthquakes, proves it vastly deeper.

The discussion of the Japan earthquake wave in 1854 by Prof. Bache, gave for the depth of the Pacific Ocean in the path of the Simoda waves to San Diego and San Francisco (34° 40′, 32° 42′, 37° 48′) a depth of 2,230 to 2,100 fathoms (13,380 to 12,600 feet).

Young estimates the average depth of the Atlantic at about 15,000 feet, and of the Pacific about 20,000 feet.

Guyot derives from the law of the relief of continents about 15,000 feet for the South Atlantic, which he suggests may be too little.

Herschel derives from the velocity of the tide wave, according to Airy's table, 22,000 feet for the Atlantic basin from lat. 50° S. to lat. 50° N. He thinks that an average depth of four miles is rather above than below the true depth.

Klöden assumes a probable average of three and a half miles, or about 18,000 feet.

There is certainly a wide difference of statement among these authorities, but we seem authorized in assuming a mean depth for the great oceanic basins of 15,000 to 18,000 feet. The greater of these numbers would still leave Mr. Sæmann's conclusions on the absorbability of the waters of the globe by its rocky mass quite within the range of probability.—*Silliman's Journal.*

LINES OF DEEPEST WATER AROUND THE BRITISH ISLES.

Rev. R. Everest, F. G. S., in a paper read before the British Association, 1861, stated that by drawing on a chart a line traversing the deepest soundings along the English Channel and the eastern coast of England and Scotland, continuing it along the one-hundred-fathom line on the Atlantic side of Scotland and Ireland, and connecting with it the line of deepest soundings along St. George's Channel, an unequal-sided hexagonal figure is described around the British Isles, and a pentagonal figure around Ireland. A hexagonal polygon may be similarly defined around the Isle of Arran. These lines were described in detail by the author, who pointed out that they limited areas similar to the polygonal form that stony or earthy bodies take in shrinking, either in the process of cooling or in drying. The relations of the one-hundred-fathom line to the promontories, the inlets, and general contour of the coast, were dwelt upon; and the bearings that certain lines drawn across the British Isles from the projecting angles of the polygon appear to have on the strike and other conditions of the strata were described. After some remarks on the probable effect that shrinkage of the earth's crust must have on the ejection of molten rock, the author observed that, in his opinion, the action of shrinking is the only one that we know of that will afford any solution of the phenomena treated of in this paper, namely, long lines of depression accompanied by long lines of elevation, often, as in the case of the British Isles, Spain and Portugal, and elsewhere, belonging to parts of huge polygons broken up into small ones, as if the surface of the earth had once formed part of a basaltic causeway.

TEMPERATURE OF THE EARTH'S CRUST.

The following paper, detailing certain recent observations on the temperature of the earth's crust, was presented to the British Association (1861) by Mr. Fairbairn, the president of the meeting:—

It is now more than ten years since a series of experiments was commenced to determine the temperature at which certain substances become fluid under pressure. These experiments had reference to the density, point of fusion, and conducting power of the materials of which the earth's crust is composed, and were prosecuted with a view to the solution of some questions regarding the probable thickness of the earth's crust. Contemporaneously with these, we were fortunate in being able to ascertain by direct experiments, under very favorable circumstances, the increase of temperature in the earth's crust itself. These observations were obtained by means of thermometers placed in bore-holes at various depths, during the sinking of one of the deepest mines in England, namely, the coal mine belonging to F. D. Astley, Esq., at Dukinfield. The bore-holes were driven to such a depth as to be unaffected by the temperature of the shaft, and the thermometers were left in them for periods varying from half an hour to two hours. It is very difficult to arrive at accurate data on the subject of the increase of temperature in the earth's crust. The experiments hitherto made give, unfortunately, somewhat conflicting results, and even in the same mine the rate of in-

crease of temperature is by no means uniform. This is shown very clearly in the results obtained by Mr. Astley. It is scarcely probable, however, that the temperature in the mine-shaft influenced the results, and we must therefore seek the cause of this irregularity in the varying conducting power of the different strata, arising from different density, and different degrees of moisture of the strata. As to the rate of increase, they appear to confirm previous experiments, in which it has been shown that the temperature increases directly as the depth. The rate is at first rather less than this, afterwards somewhat greater, and at last again less, but on the whole the straight line on which the temperature increases as the depths nearly expresses the mean of the experiments. The amount of increase indicated in these experiments is from 50° to $57\frac{3}{4}$°, as the depth increases from $5\frac{3}{4}$ yards to 231 yards, or an increase of 1° in 87 feet. But if we take the results which are more reliable, namely, those between the depths of 231 and 685 yards, we have an increase of temperature from $57\frac{3}{4}$° to $70\frac{1}{2}$° or $12\frac{3}{4}$° Fahrenheit. That is a mean increase of 1° in 76.8 feet. This rate of increase is not widely different from that observed by other authorities. Walferden and Arago found an increase of 1° in 59 feet in the artesian well at Grenelle. At the salt works at Rehme, where an artesian well penetrates to a depth of 760 yards, or rather more than the Dukinfield mine, the increase is 1° in 54.7 feet. MM. de la Rive and Marcet found an increase of 1° in 57 feet at Geneva. Other experiments have given an increase of 1° in 71 feet. In one respect the observations in the Dukinfield mine are peculiarly interesting. As they give the temperature in various descriptions of rock, they appear to prove what has hitherto been partially suspected, namely, that the conducting powers of the rocks exercise a considerable influence on the temperature of the strata. If we add to this the influence of the percolation of water, we shall probably have a sufficient explanation of the irregularities observed in the experiments. From the above observations we have evidence of the existence in the earth of central heat, the temperature, so far as can be ascertained, increasing in the simple ratio of the depth. I do not, however, presume to offer an opinion as to whether this increase continues to infinitely greater depths than we have yet penetrated, as observations upon this point are still imperfect. But assuming as an hypothesis the law which prevails to a depth of seven hundred yards continues to operate at still greater depths, we arrive at the conclusion that at a depth of less than two and a half miles the temperature of boiling water would be reached, and at a depth of forty miles a temperature of 3,000° Fahrenheit, which we may assume to be sufficient to melt the most refractory rocks of which the earth's crust is composed. If, therefore, no other circumstance modified the conditions of liquefaction, all within a thin crust of this thickness would be in a fluid state. This, however, is not the case. At these depths the fusing point is modified by the pressure and conductivity of the rocks. We know that in volcanic districts, where the great subterranean laboratory of nature is partially opened for our inspection, the molten mass, relieved from pressure, pours forth from volcanic craters currents of lava which form a peculiar class of rocks. Besides this, it has been ascertained by Mr. Hopkins's exper-

iments on soft substances, such as spermaceti, wax, and sulphur, that the temperature of fusion increases about 1.3° Fahrenheit for every 500 pounds' pressure per square inch, that is, in other words, that the temperature of fusion under pressure is increased in that ratio. If we assume this to be the law for the materials of the earth's crust, and correct our previous calculations in accordance with it, we shall find that we shall have to go to a depth of sixty-five miles, instead of merely forty, before the point of fusion of the rocks is reached. It must, however, be observed that Mr. Hopkins's later experiments with tin and barytes do not show such an increase of the point of fusion in consequence of pressure, and he is led to the belief that it is only in the more compressible substances that the law holds true. Independently of this, however, Mr. Hopkins points out to me that in the above calculation it is assumed that the conductivity of the rocks is the same at great depths as at the surface. In opposition to this, he has shown experimentally that the conducting power for heat is at least twice as great for the dense igneous rocks as for the more superficial sedimentary formations of clay, sand, chalk, etc. And these close-grained igneous rocks are those which we believe must most resemble the rocks at great depths below the surface. Now, Mr. Hopkins shows that if the conductive power were doubled, the increase of depth, corresponding to a given increase of temperature, would be doubled, and we should probably have to descend eighty or a hundred miles to reach a temperature of 3,000°, besides the further increase which investigation may show to be due to the influence of pressure on the temperature of fusion. Mr. Hopkins therefore concludes that the extreme thinness of the crust assumed by some geologists to account for volcanic phenomena is untenable. Calculations on entirely independent data led him to conclude that the thickness did not fall short of eight hundred, instead of thirty or forty, miles. If it be so much, he is further led to believe that the superficial temperature of the crust is due to some other cause than an internal fluid nucleus. It remains a problem, therefore, which my friend Mr. Hopkins is endeavoring to solve, as to what is the actual condition of the earth at great depths, and the relation of terrestrial heat to volcanic phenomena.

Mr. Hopkins said the communication which had been made by the President of the Association was worthy of more confidence than any which had hitherto been given to the public. No former treatises on this point had so largely taken into account the various circumstances in connection with mines, and the causes incident to them, which affected the temperature of the earth's crust. The condition of the rocks and walls, as well as the water in mines, must necessarily have a varying effect upon the temperature, and these facts had not received sufficient attention at the hands of those who had made experiments, but the President had now gone largely into it. One great advantage likely to result from the experiments explained in the President's paper was that the experiments had been made in a virgin mine, before it had been worked, and the temperature ascertained before being altered by working. Now, as regarded the mine in question, the stratum was very much inclined, and there was a good deal of water in it. That being the case, great caution was re-

quired in working it, because a wet mine gave a higher temperature than a dry mine. Hitherto there had been very great difficulty in making observations and experiments in mines. He had had some discussions with Professor Phillips on the subject, and he hoped that before long they would arrive at some process by which they would be enabled to make more satisfactory and conclusive experiments of the continually varying temperature in these mines, and its effects upon the incrustation of the earth.

EFFECTS OF LONG-CONTINUED HEAT.

The effects of long-continued heat, illustrative of geological phenomena, is the subject of a report by the Rev. W. Vernon Harcourt, in the volume of the *Reports of the British Association* for 1860. In 1833 the British Association intrusted a commission, consisting of Prof. Sedgwick, Dr. Daubeny, Dr. Turner, and Mr. Harcourt, with the task of illustrating geological science by experiments. To the last fell the lot of conducting a portion of these experiments in two iron furnaces in Yorkshire, at Elsecar and Low Moor, the former being worked for a period of five and the latter for fifteen years. The materials consisted of a variety of minerals in various conditions in one box, and organic remains, both of plants and animals, in another box. The various substances in the boxes were separated in crucibles. The boxes were placed in the interior of the furnaces during their erection. At the end of fifteen years the Low Moor furnace was blown out; nothing was left of the boxes but the iron straps by which they were bound, in a state of oxidation. A few crucibles and parts of crucibles only survived the wreck of their contents; all the minerals, choice pieces, weighed powders, and compositions had disappeared; and all the exactness with which Prof. Phillips had arranged them was lost labor. The deposits at Elsecar at the end of five years had not fared better. Two specimens, however, were worthy of notice. One exhibited the conversion of river sand into sandstone, with a vacuity in its axis left by the volatilization of a plant. It was a stone of much tenacity, and came out a perfect cast. The other specimen was a translucent blue mineral, belonging to the class of Lapis lazuli. Outside the boxes under the bottom stone in Low Moor furnace Mr. Harcourt had also placed other crucibles, containing a bar of zinc, a block of tin, a pig of lead, and a plate of tile copper. The changes in them were very remarkable, showing the action on each other under the heating influence.

INTERESTING FACTS RELATIVE TO THE GEOLOGICAL HISTORY OF CEYLON.

It appears from the recently-published investigations of Sir Emerson Tennent, on the natural history of Ceylon, that the elephant of Ceylon is not, as has hitherto been invariably supposed, identical with that of India, but presents numerous variations from the structure of that animal; and that it belongs to a distinct species existing only in Ceylon and Sumatra. The importance of this discovery is perhaps at first not wholly apparent, but a very little thought

serves to convince us of its wide bearings. Thus, Sir Emerson Tennent some time since brought forward a conjecture to the effect that the common theory of the island being a fragment broken off from the adjacent continent of India is unfounded and fallacious. His conjecture was based on the fact that there are various plants and animals in Ceylon for which we look in vain in the Dekkan. Nor is this all. These characteristic plants and animals, though not found in the Dekkan, are to be met with in the Malayan countries, and in some of the islands of the Eastern Archipelago. Again, the Singhalese, who people Ceylon, possess dim but numerous traditions and legends that at a period of infinite remoteness their island was part of a continent so vast that its southern extremity fell below the equator, while in breadth it extended to the shores of Africa on the one hand and China on the other.

Modern geological speculations tend in the same direction; and Professor Ansted holds that at the commencement of the Tertiary formation, while Northern Asia and a large portion of India were covered by sea, there was a continent south of India extending south and west, and connecting Malacca with Arabia. There are thus three sources from which Sir Emerson Tennent's conjecture may be confirmed: ancient traditions, geological observation, and, most reliable of all, "geographical distribution," or physical affinity.

Additional proofs coming under the third head have also recently accumulated. Thus, we find that Ceylon possesses deer, two new species of monkeys, a number of curious shrews, an orange-colored ichneumon, and various other curious quadrupeds, which are not found in the Indian fauna; then, on the other hand, the tiger and the wolf of Hindustan happily never infest the forests of the adjacent island. Of birds, again, Sir Emerson Tennent particularizes some thirty-eight species unknown at present in the continent. But the most conclusive argument is found in the discovery, to which we have alluded, that the once current notion as to there being only two species of elephants, the Indian and the African, is erroneous; and that to these must be added a third, found in Sumatra and Ceylon.

NOTES ON AMERICAN GEOLOGY.

From an article contributed to *Silliman's Journal* (May, 1861), by T. Sterry Hunt, F.R.S., of the Canadian Geological Survey, entitled, "On some Points in American Geology," we derive the following interesting summary of comparatively recent facts and theories relative to the geology of the United States and Canada: —

The oldest series of rocks, says Mr. Hunt, known in America, is that which has been investigated by the officers of the Geological Survey of Canada, and by them designated the Laurentian System. The recent investigations of Sir R. I. Murchison seem to prove the identity of these rocks with the oldest crystalline strata of western Scotland and Scandinavia, and Mr. Murchison proposes that the name Laurentian be adopted as a common appellation. These rocks are undoubtedly the oldest known strata of the earth's crust, and therefore offer peculiar interest to the geologist. As displayed in the Laurentide and Adirondack Mountains, they exhibit a volume which

has been estimated by Sir William Logan to be equal to the whole palæozoic series of North America in its greatest development. The Laurentian series consists of gneiss, generally granitoid, with great beds of quartzite, sometimes conglomerate, and three or more limestone formations (one, one thousand feet in thickness), associated with dolomites, serpentines, plumbago, and iron ores. In the upper portion of the series an extensive formation of rocks, consisting chiefly of basic feldspars without quartz and with more or less pyroxene, is met with. The peculiar characters of these latter strata, not less than the absence of argillites and talcose and chloritic schists, conjoined with various other mineralogical characteristics, seem to distinguish the Laurentian series throughout its whole extent, so far as yet studied, from any other system of crystalline strata. It appears not improbable that future researches will enable us to divide this series of rocks into two or more distinct systems.

Overlying the Laurentian series on Lake Huron and Superior, we have the Huronian system, about ten thousand feet in thickness, and consisting to a great extent of quartzites, often conglomerate, with limestones, peculiar slaty rocks, and great beds of diorite, which we are disposed to regard as altered sediments. These constitute the lower copper-bearing rocks of the lake region; and the immense beds of iron ore at Marquette and other places on the south shore of Lake Superior have lately been found by Mr. Murray to belong to this series, which is entirely wanting along the farther eastern outcrop of the Laurentian system. This Huronian series appears to be the equivalent of the Cambrian sandstones and conglomerates described by Murchison, which form mountain masses along the western coast of Scotland, where they repose in detached portions upon the Laurentian series.

Besides these systems of crystalline rocks, the latter of which is local and restricted in its distribution, we have along the great Appalachian chain from Georgia to the Gulf of St. Lawrence a third series of crystalline strata, which form the gneissoid and mica slate series of most American geologists, the hypozoic group of Professor Rogers, consisting of feldspathic gneiss, with quartzites, argillites, micaceous, epidotic, chloritic, talcose, and specular schists, accompanied with steatite, diorites, and chromiferous ophiolites. This group of strata has been recognized by Safford in Tennessee, by Rogers in Pennsylvania, and by most of the New England geologists, as forming the base of the Appalachian system, while the Canadian geologists maintain that they are really altered palæezoic sediments, and superior to the lowest fossiliferous strata of the Silurian series.

In regard to the interesting question respecting the commencement of life on the earth, Mr. Hunt says: The recognition beneath the Silurian and Huronian rocks of forty thousand feet of sediment, analogous to those of more recent times, carries far back into the past the evidence of the existence of physical and chemical conditions, similar to those of more recent periods. But these highly altered strata exclude, for the most part, organic forms, and it is only by applying to their study the same chemical principles which we now find in operation that we are led to suppose the existence of organic life during the Laurentian period. The great processes of deoxidation in

nature are dependent upon organization; plants by solar force convert water and carbonic acid into hydrocarbonaceous substances, from whence bitumens, coal, anthracite and plumbago; and it is the action of organic matter which reduces sulphates, giving rise to metallic sulphurets and sulphur. In like manner it is by the action of dissolved organic matters that oxide of iron is partially reduced and dissolved from great masses of sediments, to be subsequently accumulated in beds of iron ore. We see in the Laurentian series beds and veins of metallic sulphurets, precisely as in more recent formations, and the extensive beds of iron ore, hundreds of feet thick, which abound in that ancient system, correspond not only to great volumes of strata deprived of that metal, but, as we may suppose, to organic matters, which but for the then great diffusion of iron oxide in conditions favorable for their oxidation, might have formed deposits of mineral carbon far more extensive than those beds of plumbago which we actually meet in the Laurentian strata.

All these conditions lead us then to conclude the existence of an abundant vegetation during the Laurentian period; nor are there wanting evidences of animal life in these oldest strata. Sir William Logan has described forms occurring in the Laurentian limestone which cannot be distinguished from the silicified specimens of *Stromatopora rugosa* found in the Lower Silurian rocks. They consist of concentric layers made up of crystalline grains of white pyroxene in one case and of serpentine in another, the first imbedded in limestone and the second in dolomite; we may well suppose that the result of metamorphism would be to convert silicified fossils into silicates of lime and magnesia. The nodules of phosphate of lime in some beds of the Laurentian limestones also recall the phosphatic coprolites which are frequently met with in Lower Silurian strata, and are in the latter case the exuviæ of animals which have been fed upon *Lingula*, *Orbicula*, *Conularia*, and *Serpulites*, the shells and tubes of which we have long since shown to be similar in composition to the bones of vertebrates. So far therefore from looking upon the base of the Silurian as marking the dawn of life upon our planet, we see abundant reasons for supposing that organisms, probably as varied and abundant as those of the palæozoic age, may have existed during the long Laurentian period.

The Potsdam sandstone of the New York geologists is unquestionably the lowest rock from below Quebec to the island of Montreal, and thence passing up the valley of Lake Champlain, and sweeping around the Adirondack Mountains, it re-enters Canada and disappears to the north of Lake Ontario. In the valley of the Mississippi a sandstone exists which is believed to be the equivalent of the Potsdam.

The Potsdam sandstone of the St. Lawrence valley has for the most part the character of a littoral formation, being made up in great part of pure quartzose sand, and offering upon successive beds ripple and wind-marks, and the tracks of animals. Occasionally it includes beds of conglomerate, or encloses large rounded fragments of green and black shale; it also exhibits calcareous beds apparently marking the passage to the succeeding formation.

We may suppose, says Mr. Hunt, that while the Potsdam sandstone

was being separated along the shores of the great palæozoic ocean, the shales and limestones of the Quebec group were accumulating in deeper waters. Mr. Hunt further considers the well-known Vermont marbles of Dorset and Rutland as identified with the limestone of the Quebec group, and as beds of chemically precipitated carbonate of lime, or travertine, and not limestone of organic origin.

The Quebec group is of considerable economic interest, inasmuch as it is the great metalliferous formation of North America. To it belongs the gold which is found along the Appalachian chain from Canada to Georgia, together with lead, copper, zinc, silver, cobalt, nickel-chrome and titanium.

The immense deposits of copper ores in eastern Tennessee, and the similar ones in Lower Canada, both of which are for the most part in beds subordinate to the stratification, belong to this group. The lead, copper, zinc, cobalt, and nickel of Missouri, and the copper of Lake Superior, also occur in rocks of the same age, which appears to have been preëminently the metalliferous period.

The metals of the Quebec group seem to have been originally brought to the surface in watery solution, from which we conceive them to have been separated by the reducing agency of organic matter in the form of sulphurets, or in the native state, and mingled with the contemporaneous sediments, where they occur in beds, in disseminated grains forming *fahlbands*, or are the cementing material of conglomerates. During the subsequent metamorphism of the strata these metallic matters, being taken into solution by alkaline carbonates or sulphurets, have been redeposited in fissures in the metalliferous strata, forming veins, or, ascending to higher beds, have given rise to metalliferous veins in strata not themselves metalliferous. Such we conceive to be, in a few words, the theory of metallic deposits; they belong to a period when the primal sediments were yet impregnated with metallic compounds which were soluble in the permeating waters. The metals of the sedimentary rocks are now however for the greater part in the form of insoluble sulphurets, so that we have only traces of them in a few mineral springs, which serve to show the agencies once at work in the sediments and waters of the earth's crust.

The intervention of intense heat, sublimation and similar hypotheses to explain the origin of metallic ores, we conceive to be uncalled for. The solvent powers of solutions of alkaline carbonates, chlorides, and sulphurets, at elevated temperatures, taken in connection with the notions above enunciated, and with De Senarmont's and Daubrée's beautiful experiments on the crystallization of certain mineral species in the moist way, will suffice to form the basis of a satisfactory theory of metallic deposits.

In Eastern Canada, Messrs. Logan and Hunt recognize a group of strata which they designate as the "Quebec group," which have for their base a series of black and blue shales, and are succeeded by gray sandstones, great beds of conglomerate, with magnesian and pure limestones. These are associated with beds of fossilliferous limestones, and with slates containing graptolites, and are followed by a great thickness of red and green shales, often magnesian, and overlaid by two thousand feet of green and red sandstone, known as the

Sillery sandstone, the whole, from the base of the conglomerate, having a thickness of about seven thousand feet. These red and green shales resemble closely those at the top of the Hudson River group, and the succeeding sandstones are so much like those of the Oneida and Medina formations, that the Quebec group was for a long time regarded as belonging to the summit of the Lower Silurian series, the more so as, by a great break and upthrow to the south-east, the rocks of this group are made to overlap the Hudson River formation. This great dislocation is traceable in a gently curving line from near Lake Champlain to Quebec, passing just north of the fortress; thence it traverses the island of Orleans, leaving a band of higher strata on the northern part of the island, and after passing under the waters of the gulf, again appears on the main land about eighty miles from the extremity of Gaspé, where, on the north side of the break, we have, as in the island of Orleans, a band of Utica or Hudson River strata.

By a detail of evidence too voluminous to be presented in this article, Mr. Hunt next shows that this Quebec group is simply the greatly developed representative of the New York Potsdam and calciferous sandstones; that it is identical with the "Taconic system" of Emmons, and the true base of the Silurian system in America. He also considers that the *hypozoic series* of rocks described by Prof. H. D. Rogers as underlying the Silurian formation in Pennsylvania, the *Green Mountain gneissic formation*, and a series of limestones, sandstones and conglomerates in Tennessee, first described by Mr. Safford, and designated by him as Cambrian, are really equivalents of this Quebec group more or less metamorphosed.

METAMORPHISM OF CONGLOMERATES INTO GNEISS, TALCOSE SCHISTS, ETC.

In the May number of *Silliman's Journal* (1861), Prof. Edward Hitchcock re-discusses the subject[1] of the origin of the curious elongated, curved, and flattened quartz pebbles, which are especially noticeable in the conglomerates of Newport, R. I., and also at various localities in Vermont, and contributes much additional information to our knowledge of the phenomena in question.

Professor Hitchcock's conclusions respecting the elongated pebbles of Newport are as follows: —

1. This rock was once a conglomerate of the usual character, except in the great abundance of the pebbles, and it has subsequently experienced great metamorphoses, making the cement crystalline and schistose, and elongating and flattening the pebbles. 2. The pebbles must have been in a state more or less plastic, when they are elongated, flattened, and bent. If their shape has been thus altered, their plasticity must of course be admitted; for the attempt to change their present form would result only in fracture and comminution. The degree of plasticity however must have varied considerably; for some of them are scarcely flattened or elongated at all, and, as has been stated, some are not cut off by the joints.

[1] For a previous discussion of this subject, see *Annual of Sci. Dis.*, 1861, pp. 282, 283, 284.

The neat and clean manner in which the pebbles have been generally severed by the joints implies plasticity. For though occasionally we meet with one that has a somewhat uneven surface, as if mechanically broken, such cases are rare. Whatever may be our theory of the agency that has formed the joints, the conviction is forced upon every observer that the materials must have been in a soft state after their original consolidation. There is no evidence that the opposite walls have slid upon one another at all, as the opposite parts of the pebbles coincide. It seems as if a huge saw or cleaver had done the work.

These proofs of plasticity apply essentially though less forcibly to the micaceous and talcose cement which has also been cut across by these joints. Though generally small in quantity, it sometimes forms layers of considerable thickness interstratified with the pebbles.

Some have imagined that the elongated, flattened, bent, and indented pebbles of this conglomerate may have been worn into their present shape and brought into a parallel arrangement by the mechanical attrition of waves and currents. We feel sure that an extensive and careful examination of the localities, and of beaches where shingle is now being formed, will convince any one that they cannot have had such an origin.

In the conglomerates of Wallingford and Plymouth, Vermont, Professor Hitchcock found that the process of elongating and flattening the contained pebbles has been carried much further than at Newport, R. I. He even inclines to the opinion that conglomerates in these localities have been so operated on, while in a plastic state, by mechanical agencies that they have been converted into schists, in which these original rounded pebbles, flattened and elongated, formed the thin quartzose laminæ. In regard to this theory Professor Hitchcock uses the following language: —

"It is not probably possible for us to convey a very clear and complete idea of the evidence of this position. Would that our readers could, as we have done, visit the localities and become familiar with the striking specimens there by repeated and careful examination. From our own experience it would not surprise us if the conversion of the pebbles of conglomerates into the laminæ of schist should be pronounced preposterous by able geologists. So the idea seemed to us at first, when the facts forced it upon our attention. But as the facts compelled us to give up our scepticism, so we think it will be with any candid mind. Looking at almost any specimen of the talcose conglomerate schist, on the edge corresponding to the dip, we should see nothing but alternating laminæ of quartz and talc, or mica, and pronounce it a good example of the rock which we have called, and which is generally called, talcose schist. But a fracture at right angles reveals the flattened pebbles, and shows us that the edges are what we have regarded as laminæ. Let the process of flattening be carried a little farther, and no evidence will remain that they ever were pebbles. Who knows how extensively the process may have been thus carried through in the schists and gneiss of the Green Mountains, and how large a part of them may once have been conglomerate?"

THE TACONIC SYSTEM.

The geological questions involved in the so-called "Taconic System" of Dr. Emmons have continued during the past year greatly to interest the attention of American and European geologists, and the discussions relative thereto have occupied to a considerable extent the pages of *Silliman's Journal*, and the *Proceedings of the Boston Natural History Society*. To attempt to give even a brief resumé of the recent discussions of the subject would occupy a greater space than the limits of the present volume will allow; but it is sufficient, however, to say that the geological views expressed by Dr. Emmons in 1844, and which have since been scouted at and ridiculed by most American geologists, and which have even been taken advantage of by certain unscrupulous scientific opponents to bring Dr. Emmons's name and character into contempt before the public, have now been admitted by all geologists to be true *in part*, and by many to be true altogether. The essential points involved in this subject of the Taconic System are thus clearly presented in the March (1861) number of *Silliman's Journal:* —

"The rocks under discussion occupy a belt of country east and west from twenty to sixty miles wide, stretching from the vicinity of the city of New York in a northerly direction to Lake Champlain, and thence through Vermont and Lower Canada to Cape Gaspé at the mouth of the St. Lawrence. The strata, consisting of slates, limestones, sandstones, and conglomerates, are greatly disturbed, plicated and dislocated, and are often, especially along the eastern side of the belt, in a highly metamorphic condition. On this side they are overlaid unconformably by Upper Silurian and Devonian rocks, but on the western and northern margin they are in contact with, and in general seem to be a continuation of, the Lower Silurian. Some of the slates of the formation closely resemble in lithological characters those of the Hudson River group, and thus along the western side of the region, where the junction of the two formations occurs, it is often impossible to draw the line between them. The dip and strike of both are in the same direction, and throughout extensive areas the newer rocks appear to plunge beneath the older. The whole district affords an excellent example of those cases, so well known to field geologists, where the true relations of the different masses cannot be clearly worked out without the aid of fossils, and where the best of observers may arrive at diametrically opposite opinions.

"Dr. Emmons, one of the geologists of the New York Survey, early convinced himself, by a careful examination of these rocks, that they constituted a distinct physical group more ancient than the Potsdam sandstone, the latter being regarded by him as the base of the Lower Silurian system in North America. His views were given in detail in 1842 in his final report on that part of the State confided to his charge, and in a more special manner in another work entitled *The Taconic System*, published in 1844. In this latter work he figured several species of fossils which had been collected in different parts of the formation. Two of these were trilobites, and were described under the names of *Atops trilineatus* and *Elliptocephala asaphoides*. The others were graptolites, fucoides, and apparently trails of anel-

lides. He considered all the species to be distinct from any that had been found in American rocks of undoubted Silurian age. The pre-silurian age of the formation has also been maintained by him in several more recent publications, such as his *American Geology*, the several reports on the geological survey of North Carolina, and in his *Manual of Geology*.

"On the other hand, Professor Hall placed the whole region in the Hudson River group. In the first volume of the Palæontology of New York he identifies *Atops trilineatus* with *Triarthrus Beckii*, the characteristic trilobite of the Utica slate; *Elliptocephala asaphoides* he refers to the genus *Olenus*, and describes as congeneric therewith another trilobite (*O. undulostriatus*), said to be from the true Hudson River shales. It is scarcely necessary to state that these identifications have always afforded an extremely powerful objection against the correctness of the position assumed by Emmons, because no species of trilobite is known to range from the Primordial Zone up to the top of the Lower Silurian. Hall's first volume was published in 1847, and as it is unquestionably the most important work on the Lower Silurian Fossils of North America, it has been generally accepted by our physical geologists as a guide. It is not surprising therefore that, in all the discussions that have taken place during the last fourteen years upon the age of these rocks, the majority of those who did not profess to be naturalists should have arranged themselves on the side of the leading palæontologist of the country.

"The formation was traced from New York through Vermont, and there identified, by Professor Adams, the State Geologist, with the Hudson River group. The Canadian surveyors continued it with great labor through a mountainous and partially uninhabited country for nearly five hundred miles further, from the northern extremity of Vermont to the neighborhood of Quebec, and thence along the side of the St. Lawrence to the mouth of that river at Cape Gaspé. In Canada the nomenclature of the New York Survey was adopted for all the formations, and it appears from his several reports that Sir W. E. Logan could find nothing in the physical structure of the country to authorize him to make an exception in favor of this particular series of rock. It has therefore always been called the Hudson River group in the publications of the Canadian Survey."

Within a comparatively recent period, however, Sir William Logan and the Canadian geologists have found in the rocks in the vicinity of Quebec, heretofore referred by them, in opposition to the views of Dr. Emmons, to the age of the Hudson group, a large number of fossils which prove unquestionably that the Quebec rocks are at least as ancient as the strata acknowledged to form the base of the Silurian System, or the "Potsdam sandstone," and as, in Vermont, strata, regarded of the same age as the Quebec rocks, appear to be subordinate to the Potsdam sandstone, it follows the position contended for by Dr. Emmons is probably true.

If the views of Dr. Emmons are to be accepted as entirely in conformity with the real truth, it would seem as if the name "Taconic System," given by him to the lowest group of stratified rocks, ought to supplant the names "Huronian" and "Laurentian" adopted by the Canadian geologists; the former being considered as the "Upper

Taconic" and the latter as the "Lower Taconic." (See *Marcou, Proc. Bos. Soc. Nat. Hist.*, 1861, pp. 246, 247.)

THE APPALACHIAN MOUNTAIN SYSTEM.

Professor Guyot, whose researches in respect to the great Appalachian or Alleghany Mountain System of North America have been before noticed in previous volumes of the *Annual of Scientific Discovery*, communicates to *Silliman's Journal* for March, 1861, a very elaborate paper on the above subject, accompanied by a map and a table of the heights of nearly all the principal peaks of this range of mountains. From this paper we derive the following memoranda: —

The remark has been made with justice that the Appalachian or Alleghany system of mountains, although situated in the midst of a civilized nation, is still one of the chains concerning which we have the least amount of positive knowledge. This is due in a considerable degree to the obstacles, often very great, which the explorer meets in these wild regions. A chain of thirteen hundred miles in length is a vast field, especially when it includes mountains covered with interminable forests, where a footpath rarely guides the traveller's step, and which it is impossible to cross except with a hatchet in the hand, and with a loss of time and strength often quite disproportionate to the results which are obtained. Add to this, that in many parts of the system the journey is to be made in an unknown region, without a reliable map, far from a human dwelling, rarely penetrated by the most hardy hunters. The explorer must be ready to march without any trusty guide, and to sleep in the open air, exposed to the inclement temperature of the elevated regions, and obliged to depend for nourishment on the food which he can carry with him. In these circumstances the danger of perishing from exhaustion is by no means imaginary.

In a great portion of the Appalachian chain, especially towards the south, the lofty forests, which crown nearly all the summits, and the thick underbrush, literally impenetrable, of rhododendrons and other evergreens, in which the faint track of the bear is often the only assistance of the traveller, are not less serious obstacles. The difficulty of obtaining general views, enabling one to take his bearings in the labyrinth of mountains which cover the country, is thus considerably increased; and the favorable points of observation which are necessary to determine the position of the peaks which are measured or to be measured, and for identifying them in every case, are by no means numerous.

The upheavals of ancient rocks which constitute the general structure of the Appalachian system extend in an undulating line thirteen hundred miles in a mean direction of north-east to south-west, from the promontory of Gaspé upon the Gulf of St. Lawrence to Alabama, where the terminal chains sink down, and are lost in the recent and almost horizontal strata of the cretaceous and tertiary formations which cover the greater portion of the surface of that State. This long range of elevations is composed of a considerable number of chains, sensibly parallel to each other, occupying more particularly

the eastern part which faces the ocean, and of an extended plateau which prevails towards the west and north-west and descends gradually towards the inland valleys of the St. Lawrence, the Lakes Erie and Ontario, and the Ohio River.

The base on which this large belt of mountains rests, and which may be considered as bounded by the Atlantic Ocean on one side and by the Ohio and St. Lawrence Rivers on the other, is formed in the east by a plain slightly inclined towards the Atlantic. The width of that plain in New England does not vary much from fifty miles. Near the mouth of the Hudson, however, in New Jersey, it nearly disappears, but gradually increases towards the south to a width of over two hundred miles. Its elevation above the sea, at the foot of the mountains, is in New England from three hundred to five hundred feet. From the neighborhood of the Bay of New York, where it is nearly on a level with the ocean, it rises gradually towards the south to an altitude of over one thousand feet. On the west the table-lands which border upon the Ohio River, and which may be considered as the general base of the system, preserve a mass elevation of a thousand feet or more, in the thickness of which the river-bed is scooped out to the depth of from four hundred to six hundred feet, thus reducing the altitude of the Ohio River full one-half from that of the surrounding lands.

The vast belt of the Appalachian highlands forms the marginal barrier of the American continent on the Atlantic side, and determines the general direction of the coast line, which in general runs parallel to the inflections of its chains with remarkable regularity.

When from any point we traverse the Appalachian system from the Atlantic, we encounter first a zone which shows that they are but the last undulations due to the action of the same forces which have upheaved and folded that region, and which have raised at the same time the mass of these more uniform plateaus. Thus, when from any point we traverse the Appalachian system from the Atlantic, we encounter first a plain more and more undulated and gradually ascending to the foot of the mountains; then a mountainous zone with its ranges parallel and its valleys longitudinal; at length a third zone of uniform plateaus slightly inclined towards the north-west, and cut with deep transverse valleys.

Another conspicuous feature of the Appalachian system is a large central valley which passes through the entire system from north to south, forming, as it were, a negative axis through its entire length. This is what Mr. Rogers calls the Great Appalachian Valley. At the north it is occupied by Lake Champlain and the Hudson River; in Pennsylvania it bears the name of Kittatinny, or Cumberland Valley. In Virginia it is the Great Valley; more to the south it is called the Valley of East Tennessee. At the north-east and at the centre its average breadth is fifteen miles; it contracts in breadth towards the south, in Virginia, but reaches its greatest dimensions in Tennessee, where it measures from fifty to sixty miles in breadth. The chain, more or less compound, which borders this great valley towards the south-east is the more continuous, and extends without any great interruption from Vermont to Alabama. In Vermont it bears the name of Green Mountains, which it retains to the borders of New

York; in the latter State it becomes the Highlands; in Pennsylvania, the South Mountains; in Virginia, the Blue Ridge; in North Carolina and Tennessee, the Iron, Smoky, and Unaka Mountains. On the north-west of the great valley, between the latter and the borders of the plateau parallel, there extends a middle zone of chains separated by narrow valleys, the more continuous of which is the range which bounds the central valley. This zone has a variable breadth in different parts of the system, and the number of chains which compose it is by no means uniform throughout.

Passing the eye over a map of the system, we at once distinguish in its longitudinal extent two principal curvatures: the one at the north, from Gaspé to New York, the concavity of which is turned towards the south-east; the other at the centre, from the Hudson to New River in Virginia, with its concavity also towards the south-east; the third from New River to the south-west extremity of the system, the direction of which is nearly straight, or forming a gentle curve concave to the north-west. These three divisions, diminishing in extent from north to south, are well marked at the north by the Mohawk and Hudson Rivers, which break through the Appalachian system to its base and across its entire breadth; and at the south by the deep valley of the New River.

The *northern division* is much the most isolated; it is also geologically the most ancient, since its upheavals appear coeval with the Silurian and Devonian epochs, and are thus much anterior to the rest of the system, which only emerged after the deposit of the carboniferous rocks which it has elevated. Four hundred feet more of water would separate all the vast territory of the northern division from the American continent. One hundred and forty feet would convert into an island all New England and the British Possessions as far as Gaspé; for the bottom of the valley occupied by Lake Champlain and the Hudson does not in any part exceed this level.

The *southern division*, from New River to the extremity of the system, is much the most remarkable for the diversity of its physical structure and its general altitude. Even the base upon which the mountains repose is considerably elevated. Although the elevation of the Atlantic plain at the eastern base of the mountains is only one hundred to three hundred feet in Pennsylvania, and five hundred in Virginia near James River, it is one thousand to one thousand two hundred feet in the region of the sources of the Catawba. In the interior of the mountain region the deepest valleys retain an altitude of two thousand to two thousand seven hundred feet.

In the region of country comprised between the Blue Ridge and the great chain of the Iron, Smoky, and Unaka Mountains which separate North Carolina from Tennessee, through an extent of more than one hundred and fifty miles, the mean height of the valley from which the mountains rise is more than two thousand feet; the mountains which reach six thousand feet are counted by scores, and the loftiest peaks rise to six thousand seven hundred feet; while at the north, in the group of the White Mountains, the base is scarcely one thousand feet, the gaps two thousand feet, and Mount Washington, the only one which rises above six thousand feet, is still four hundred feet below the height of the Black Dome of the Black Mountains of

North Carolina. Here then, in all respects, is the culminating region of the vast Appalachian system.

Professor Guyot also notices at length the remarkable depression in the Appalachian system between the northern and middle divisions, above referred to, which attains its lowest point in New Jersey, in the parallel of New York city. This depression causes the continental plains which form the natural base of the mountain system to disappear at this point under the waters of the ocean. The waters of the tide thus come to bathe the very base of the mountains, and the region of plains fades away on the frontiers of New Jersey and New York, while towards the south the plains at the base of the mountains gradually enlarge, and in North Carolina reach a breadth of over two hundred miles.

This depression seems to be due to a local subsidence of the earth's crust at an epoch undetermined, it is true, but which must have been posterior to the principal upheaval of the Appalachian Mountains. A fact, the discovery of which is due to the sagacity of Prof. J. D. Dana, seems to give weight to this opinion. He demonstrated by means of numerous soundings, marked upon the excellent marine chart published by the United States Coast Survey, the existence of an ancient channel, a continuation of that of the Hudson River, which goes out from the Bay of New York through the Narrows, and advances far out under the waters of the ocean. It is not possible to suppose that such a channel, which is constantly liable to be obliterated by sand-banks formed by the motion of the sea, could have ever been formed in its present position. In order that the current of the river should excavate this channel it is necessary to suppose that the bottom of the sea has once occupied a higher level, above or very near the surface of the ocean. The shallowness of the ocean for a considerable distance from the coast of New Jersey also indicates a prolongation of the continental plains under the sea, and the limit of the deep waters is there found at a distance nearly double that which is observed off the coast of the Carolinas. Moreover, the parallelism which exists between the line of coasts and all the great general inflections of the Appalachian system, a parallelism which is well marked from Nova Scotia to Florida, here undergoes a modification which is well explained only by a local depression of this part of the system. The fact that all New Jersey is now undergoing gradual submergence from Cape May to the Bay of New York, which is proved by numerous facts gathered in the Geological Survey of the State of New Jersey, is here not without signification.

NOTES ON THE HISTORY OF PETROLEUM, OR ROCK OIL.

In the *Canadian Naturalist* (July, 1861), Mr. T. Sterry Hunt, F. R. S., of the Canadian Geological Survey, gives the following comprehensive *resumé* of the most important facts thus far made known respecting the geological history of the various substances designated as "petroleum," "rock oil," "naphtha," "asphalt," "mineral pitch," etc. All of these, says Mr. Hunt, are forms of bitumen, some of which are solid, and others fluid, at ordinary temperatures; the more liquid being mixtures of oils differing in volatility, which by exposure

to the air become less fluid, and, partially by evaporation, partly by oxidation from the air, eventually become solid and changed into mineral pitch. These substances, which are doubtless of organic origin, occur in rocks of all ages, from the Lower Silurian to the Tertiary period inclusive, and are generally found impregnating limestones, and more rarely sandstones and shales. Their presence in the lower palæozoic rocks, which contain no traces of land plants, shows that they have not in all cases been derived from terrestrial vegetation, but may have been formed from marine plants and animals; the latter is not surprising when we consider that a considerable portion of the tissues of the lower marine animals is destitute of nitrogen, and very similar in chemical composition to the woody fibre of plants. Besides the rocks which contain true bitumen, we have what are called bituminous shales, which, when heated, burn with flame, and by distillation at a high temperature yield, besides inflammable gases, a portion of oil not unlike in its characters to petroleum. These are in fact argillaceous rocks intermixed with a portion of organic matter allied to peat or lignite, which by heat is decomposed, and gives rise to oily hydrocarbons. These inflammable or lignitic shales, which may be conveniently distinguished by the name of *pyroschists*, are to be carefully distinguished from rocks containing ready-formed bitumen; this, being easily soluble in benzole or sulphide of carbon, can be readily dissolved from the rocks in which it occurs, while the pyroschists in question yield, like coal and lignite, little or nothing to these liquids.

It is the more necessary to insist upon the distinction between lignitic and bituminous rocks, inasmuch as some have been disposed to regard the former as the source of the bitumen found in nature, which they conceive to have originated from a slow distillation of these matters. The result of a careful examination of the question has, however, led us to the conclusion that the formation of the one excludes more or less completely that of the other, and that bitumen has been generated under conditions different from those which have transformed organic matters into coal and lignite, and probably in deep water deposits, from which atmospheric oxygen was excluded. Thus in the palæozoic strata of North America we find in the Utica and Hamilton formations highly inflammable pyroschists, which contain no soluble bitumen, and the same is true, to a certain extent, of some limestones, while the Trenton and Corniferous limestones of the same series are impregnated with petroleum or mineral pitch, and, as we shall show, give rise to petroleum springs. The fact that intermediate porous strata of similar mineral characters are destitute of bitumen shows that this material cannot have been derived from overlying or underlying beds, but has been generated by the transformation of organic matters in the strata in which it is met with. This conclusion is in accordance with that arrived at by Mr. Wall in his recent investigations in Trinidad. He has shown that the asphalt of that island and of Venezuela belongs to strata of the tertiary formation (of upper miocene or lower pliocene age), which consists of limestones, sandstones, and shales, associated with beds of lignite. The bitumen is found not only in the famous pitch lake but *in situ*, where it is confined to particular strata which were originally shales containing veg-

etable remains; these have undergone "a special mineralization producing a bituminous matter instead of coal or lignite. This operation is not attributable to heat, nor of the nature of a distillation, but is due to chemical reactions at the ordinary temperature, and under the normal conditions of climate." He also describes wood partially converted into bitumen, which last, when removed by solution, leaves a portion of woody tissue.

The sources of petroleum and mineral pitch in Europe and in Asia are for the most part, like those just named, confined to rocks of newer secondary and tertiary age, though they are not wanting in the palæozoic strata, which in Canada and the United States furnish such abundant supplies of petroleum. In the great palæozoic basin of North America, bitumen, either in a liquid or solid state, is found in the strata at several different horizons. The forms in which it now occurs depend in great measure upon the presence or absence of atmospheric oxygen, since by oxidation and volatilization the naphtha or petroleum, as we have already explained, becomes slowly changed into asphalt or mineral pitch, which is solid at ordinary temperature. It would even appear that by a continuance of the same action the bitumen may lose its fusibility and solubility and become converted into a coal-like matter. Thus, in the calciferous sand-rock in New York, a black substance, which has been called anthracite, occurs in cavities with crystals of bitter spar and quartz. It sometimes coats these crystals or the walls of the cavities, and at other times appears in the form of buttons or drops, evidently, according to Mr. Vanuxem, having been introduced into these cavities in a liquid state, and subsequently hardened as a layer above the crystals, which have conformed to them, showing that this coal-like matter was once in a plastic state. A similar material occurs in the Quebec group in Canada, the equivalent of the calciferous sand-rock, and fills cavities and fissures in the limestones, sandstones, and even in the accompanying trap rocks, presenting mammillary surfaces, which evidently show that it has once been semi-fluid.

An evidence of the presence of unaltered petroleum in almost all the Lower Silurian limestones is furnished by the bituminous odor which they generally exhibit when heated, struck, or dissolved in acids. In some cases petroleum is found filling cavities in these limestones, as at Rivière à la Rose (Montmorenci), where it flows in drops from a fossil coral of the Birdseye limestone, and at Pakenham, where it fills the cavities of large orthoceratites in the Trenton. The presence of petroleum in the Lower Silurian rocks of New York is shown in the township of Guilderland, near Albany, where, according to Beck, considerable quantities of petroleum are collected upon the surface of a spring which rises through the Hudson River or Lorraine shales. On the Great Manitoulin Island also, according to Mr. Murray, a petroleum spring issues from the Utica slate, and he has described another at Albion Mills, near Hamilton, rising through the red shales of the Medina group; these have probably their origin in the Lower Silurian limestones, which may in some localities prove to be valuable sources of petroleum.

In the Upper Silurian and Devonian rocks bitumen is much more abundant; Eaton long since described petroleum as exuding from the

Niagara limestone, and this formation throughout Monroe County in Western New York, is described by Mr. Hall as a granular crystalline dolomite, including small laminæ of bitumen, which give it a resinous lustre. When the stone is burned for lime the bitumen is sometimes so abundant as to flow like tar from the kiln. In the Corniferous limestone, at Black Rock, on the Niagara River, petroleum is described as occurring in cavities, generally in the cells of fossil corals, from which, when broken, it flows in considerable quantities. It also occurs in similar conditions in the Cliff limestone (Devonian) of Ohio.

Higher still in the series, the sandstones of the Portage and Chemung group in New York are in many places highly bituminous to the smell, and often contain cavities filled with petroleum, and in some places seams of indurated bitumen. In the counties of Erie, Seneca, and Cattaraugus abundant oil-springs rise from these sandstones, and have been known to the Seneca Indians from ancient times. In the northern part of Ohio, according to Dr. Newberry, petroleum is found to exude in greater or less quantity from these sandstones wherever they are exposed, and the oil-wells of Pennsylvania and Ohio are sunk in the same Devonian sandstones, often through the overlying carboniferous conglomerate, and in some cases apparently, according to Newberry, through the sandstones themselves, which are supposed by him to be only reservoirs in which the oil accumulates as it rises through fissures from a deeper source, in proof of which he mentions that in boring wells near to each other the most abundant flow of oil is met with at variable depths. In some instances the petroleum appears to filter slowly into the wells from the porous strata around, which are saturated with it, while at other times the bore seems to strike upon a fissure communicating with a reservoir which furnishes at once great volumes of oil. An interesting fact is mentioned in this connection by Mr. Hall. In the town of Freedom, Cattaraugus County, New York, is a spring which had long been known to furnish considerable quantities of petroleum. On making an excavation about six yards distant, to the depth of fourteen feet, a copious spring of petroleum arose, and for some time afforded large quantities of oil, after which the supply diminished in both the old and new springs, so that it is now less than at the first settlement of the country. Notwithstanding its general distribution throughout a considerable region in the adjacent portions of New York, Pennsylvania, and Ohio, it is only in a few districts that it has been found in quantities sufficient to be wrought with profit. The wells of Mecca, in Trumbull County, Ohio, have been sunk from thirty to two hundred feet in a sandstone which is saturated with oil; of two hundred wells which have been bored, according to Dr. Newberry, a dozen or more are successfully wrought, and yield from five to twenty barrels a day. The wells of Titusville, on Oil Creek, Pennsylvania, vary in depth from seventy to three hundred feet, and the petroleum is met with throughout. The oil from different localities varies considerably in color and thickness, and in its specific gravity.

The valley of the Little Kenawha, in Virginia, which is to be looked upon as an extension of the same oil-bearing region, contains petroleum springs, which so long ago as 1836, according to Dr.

Hildreth, yielded from fifty to a hundred barrels yearly. It here rises through the carboniferous strata, and, as elsewhere, is accompanied by great quantities of inflammable gas.

For many years bitumen in the solid form has been used for the construction of pavements, for paying the bottoms of ships, and for the manufacture of gas; but in the liquid form of petroleum, its use was mainly confined in Europe to medicinal purposes. Under the names of Seneca oil and Barbadoes tar it had long been known and employed medicinally by the native tribes of America. Its use for burning, as a source of light or heat, in modern times has been chiefly confined to Persia and other parts of Asia, although in former ages the wells of the island of Zante, described by Herodotus, furnished large quantities of it to the Grecian Archipelago, and Pliny and Dioscorides describe the petroleum of Agrigentum, in Sicily, which was used in lamps under the name of Sicilian oil. The value of the naphtha annually obtained from the springs at Bakoum, in Persia, on the Caspian Sea, was some years since estimated by Abich at about six hundred thousand dollars, and the petroleum wells of Rangoon, in Burmah, are said to furnish not less than four hundred thousand hogsheads yearly. In the last century the petroleum or naphtha obtained from springs in the duchy of Parma was employed for lighting the streets of Genoa and Amiano. But the thickness, coarseness, and unpleasant odor of the petroleum from most sources were such that it had long fallen into disuse in Europe, when, in 1847, the attention of Mr. Young, a manufacturing chemist of Glasgow, was called to the petroleum which had just been obtained in considerable quantities from a coal mine in Derbyshire, from which, by certain refining processes, he succeeded in preparing a good lubricating oil. This source, however, soon becoming exhausted, he turned his attention to the somewhat similar oils which Reichenbach and Selligue had long before shown might be economically obtained by the distillation of coal, lignite, peat, and pyroschists. To this new industry Mr. Young gave a great impetus, and, in connection with it, attention was again turned to the refining of liquid and solid bitumens, it being found that the latter by distillation gave great quantities of oils identical with those from petroleum.[1]

The oil-wells of the United States are, for the most part, sunk in the sandstones which form the summit of the Devonian series, but the oils of Western Virginia and Southern Ohio rise through the coal measures which overlie the Devonian strata; while the principal wells of Canada are situated much lower, and are sunk in the Hamilton shales, which immediately overlie the Corniferous or Devonian limestone. It is not impossible that in Ohio some of the higher strata, such as the sandstone, were originally impregnated with bitumen,

[1] A few years ago, Mr. Young testified in court, in England, to having manufactured by distillation from coal and sold in one year over 400,000 gallons of oil for lubricating purposes.

As yet, the attention of refiners of coal-oil and petroleum in this country has been confined to the products most readily derived from them, viz., burning fluid, lubricating oil, and paraffine; but the European manufactures have demonstrated that the process may be profitably carried much farther, and that other and more valuable secondary products may be derived from those first mentioned.

but in Canada, from the absence of this substance, diffused through the shales in question, we are forced to assign it to a lower horizon, which is doubtless that of the bituminous Devonian limestone.

The question of the extent of the supply of petroleum is not easily answered; the oil now being wrought is the accumulated drainings of ages, concentrated along certain lines of elevation, and the experience of other regions has shown that these sources are sooner or later exhausted; but though the springs of Agrigentum, like those of Derbyshire, have nearly ceased to flow, those of Burmah and Persia still furnish, as they have for ages past, immense quantities of oil. Nothing but experience can tell us the richness of the subterranean reservoirs.[1]

Professor Newberry, the well-known geologist, in a recent pamphlet on the *Rock Oils of Ohio*, presents the following explanation of the origin of petroleum: —

Petroleum has usually been produced from bituminized plants, but those varieties of it which are obtained from rocks filled with animal remains, as highly fossiliferous limestones, and which have a peculiarly strong and disagreeable odor, in virtue of the sulphur and nitrogen which they contain, are probably for the most part of animal origin.

The precise process by which petroleum is evolved from the carbonaceous matters contained in the rocks which furnish it, is not yet fully known, because we cannot in ordinary circumstances inspect it. We may fairly infer, however, that it is a *distillation*, though generally performed at a low temperature. Carburetted hydrogen is rapidly produced from bituminous substances by artificial dry distillation. So it is evolved in nature, at low temperatures, from submerged, and doubtless emerged, vegetable matter. It is also thrown off in immense quantities by the spontaneous distillation of bituminous coal in mines. Doubtless the same is true of the *liquid* hydro-carbons. Though less observable than the gases, I think they may often, if not always, be detected among the products of decomposition of submerged vegetable tissue. This at least we may safely affirm, that their spontaneous production on a large scale in nature may generally be traced to extensive accumulations of bituminized vegetation from which they have been derived. From this they are evolved by a kind of distillation, which differs from our artificial process in

[1] Prof. E. B. Andrews, in an article in *Silliman's Journal* for July, 1861, on the "Geological Relations and Distribution of Rock Oil," thus speaks of the Little Kenawha oil region of West Co., Virginia: "The oil fissures are struck at different depths, as has been already shown, consequently there is no such thing as an 'oil rock,' as many suppose. The oil is found in any kind of stratum. Each oil fissure doubtless extends vertically, or nearly so, through many different strata. These wells have been unparalleled for the quantity of oil produced. Many of them, when first bored, poured out the oil in torrents, the oil being forced up by the pressure of gas. Hundreds of barrels were obtained from a well in a few hours.

"The oil is evidently the accumulation of long ages. The valleys of erosion which cross this line of uplift in almost every direction, and which have been produced by the drainage of the rains falling upon the surface, show that the uplift, and consequently the fissures underneath, have existed for a vast period of time. It is therefore probable that during this long period the work of accumulation has been going on. If this is true, it will follow that when a fissure is once exhausted of oil, it may well be abandoned, as it will take a geological period to refill it."

wanting, in many cases at least, the condition of high temperature, but including the perhaps no less potent elements of time and pressure.

Production of Petroleum.—The amount of petroleum (rock oil) *daily* drawn from wells bored to obtain it in the States of Pennsylvania and Ohio was estimated by Prof. Newberry, for 1860–61, to be not less than five hundred barrels, or over five million gallons yearly. The amount of rock oil which passed over one of the Pennsylvania railroads—the Erie and Philadelphia—during the month of January, 1862, is reported to have been thirty thousand barrels. Oil in large quantities is also obtained in Canada and Kentucky; and its collection, transportation, refining and vending has, in all the above-mentioned localities, given a prodigious impulse to enterprise and industry, giving employment to thousands, trebling the population of some towns, starting others into existence, and causing the construction even of lines of railroads. In fact, there is probably no business in the world which has grown to such magnitude in so brief a period.

PRODUCTION OF THE CRYSTALLINE LIMESTONES.

In most modern treatises on geology an experiment, made by Sir James Hall in 1804, of subjecting chalk, contained in a tight gun-barrel, to an intense heat, is quoted as explanatory of the origin of the crystalline limestones or marbles. Experiments of the same nature made during the past year by Rosé, show, however, that chalk or compact limestone cannot be converted into crystalline limestone by exposure to a high temperature in closed vessels; and that the conclusions of Mr. Hall, so often quoted, were erroneous, and probably founded on a hasty and imperfect examination of the results he obtained. It is not however, says M. Rosé, to be disputed that at the junction with granite and basalt, compact limestone and chalk are often converted into marble, but these changes cannot be considered as due to heat alone; they were manifestly assisted by other agencies.—*Silliman's Journal*, July, 1861.

ORIGIN OF THE WESTERN PRAIRIES.

M. Leo Lesquereux, the well-known geologist, who has carefully studied the prairies of the Mississippi valley, ascribes their general formation to the agency of water. He says:—

All the prairies still in a state of formation along the great lakes of the north are nothing else but marshes slowly passing to dry land by slow recession of water. When land is continually covered by low stagnant water, its only vegetation is that of the rushes and of the sedges. When the same land is alternately subjected to long inundations and then to dryness, during some months of the year, the same plants continue to cover it. By their decomposition these marshy plants produce a peculiar ground, either black, light, permeable when it is mixed with sand, as it is near the borders of the lakes, or hard, cold, impermeable when it is mixed with clay or muddy alluvium, as in some marshes underlaid by clay or shales, or along the banks of some rivers. Land continually covered with

stagnant water cannot produce any trees, because the trees require for their growth, like most of the terrestrial plants, the introduction of atmospheric air to their roots. Neither do trees germinate and grow on a ground alternately covered with stagnant water and exposed to dryness for some months of the year. From these considerations, the law of the general formation of the prairies can be deduced: While a land or a part of a country is slowly passing from the state of swamp or marsh to the state of dry land, the annual alternation of stagnant water and dryness causes the vegetation of peculiar plants, which, by their decomposition, form a peculiar soil unfavorable to the growth of the trees. From this general rule of formation, which regards only the prairies of the Mississippi valley,[1] all the different phenomena or peculiar appearances of the prairies can be easily explained.

CURIOUS ILLUSTRATION OF THE DRIFT AGENCY.

At the close of a recent geological discussion at the Cooper Institute, New York city, Professor Mason remarked that several years since he happened to have a conversation with a man who had spent his life in buying and selling land, and the man told him that he very soon learned not to take up land on the north side of a hill. Professor Mason said that his attention being thus called to the matter, he had made very extensive observations and inquiries, which had fully confirmed the opinion of the speculator. He added, if any one who has occasion to ride from New York to Canada will observe, he will see that the lands are generally cleared for cultivation upon the south sides of the hills, while the forests are left standing upon the north sides, which are comparatively barren; the currents of the drift period, coming from the north, and impinging directly upon the northern slopes, having washed the soil and *debris* from their surfaces.

CONTRIBUTIONS TO OUR KNOWLEDGE OF COAL.

Prof. J. W. Dawson, of McGill College, Canada, has lately published, in the *Proceedings of the Geological Society of London*, two very interesting memoirs: one concerning the vegetable structure in coal; the other on a terrestrial mollusk, a *Myriapod*, and some new species of reptiles from the coal of Nova Scotia.

The formation of the coal and the composition of its combustible matter may be considered as settled questions. But we are still far from being well acquainted with the true nature of the coal plants, and with their generic and specific affinities. Fossil plants are found preserved in two different ways. In the shales and the sandstones the outline of the vegetable is marked just as it would be on the stone by the pencil of a lithographer, but no trace of internal structure is preserved; and as these remains are mostly broken parts of stems and of leaves, crushed cones, scales or blades, nutlets and prints of various forms left on the bark of some trees at the point of attachment of the leaves, it is nearly impossible to determine

[1] The prairies of the far West, along the eastern base of the Rocky Mountains, are true sandy deserts, caused by the dryness of the atmosphere.

with precision the species to which such fragments belong, or at least to get any indication about their mode of vegetation and their relation to plants now living. In the coal, on the contrary, we find a few remains of internal organism, chiefly vessels of various appearances. But in the compact, homogeneous matter of the coal, every trace of external structure of the plants having disappeared, these isolated vessels cannot in any way indicate the form of the plant to which they belong.

It is especially in treating the laminæ of mineral charcoal, intermixed with compact coal, by chemical maceration, that Professor Dawson has been able to separate the vegetable fibre and to study the form of some of the vessels. The result of these researches is satisfactory to this point: it proves by a direct experiment that the coal is a compound of different species of plants. Though many palæontologists had already come to the same conclusions by researches of the same kind, Professor Dawson is the first who has succeeded in clearing the woody fibre perfectly from every particle of amorphous substance, and thus his assertions are more conclusive and more reliable. Nevertheless, some of these assertions are open to critical discussion.

One of the most interesting conclusions reached by Professor Dawson is that the small cylindrical filaments, resembling black threads, so abundant in the coal, are composed of *bundles* of scalariform vessels inclosed in a sheaf of woody fibres. This is, says the author, precisely the structure of the vascular bundles of the petioles of ferns.

The question as to the real character of the *Stigmaria ficoides* cannot be considered as settled, and it is by no means certain that it is the root of a Sigillaria.

It is scarcely possible now to refer the genus *Sigillaria* to *Cycadeæ* or to the *Coniferæ*. Neither the internal structure nor what we know of the external forms of species of this genus, the leaves, the fruits, etc., can show such an analogy. Professor Dawson cannot with certainty affirm the presence of tissue of true Conifers in the coal. This agrees perfectly with the results of M. Lesquereux's researches, who states that no trace of a coniferous plant has yet been found in the coal measures of the United States.

In his second paper, Professor Dawson most satisfactorily confirms a former discovery, made by himself and Sir Charles Lyell, of the presence of terrestrial animals in the coal measures of Nova Scotia. In like circumstances, namely, in the hollow petrified trunk of a standing tree, he has found numerous well-preserved specimens of the same land shell, *Pupa vetusta* Daw., before discovered at the same locality; some remains of a new genus and species of an articulated animal, resembling a Myriapod, and portions of two skeletons of animals belonging to a new *reptilian* genus, *Hylonomus*.

Every geologist will recognize the great importance of this discovery, as respects both palæontology and the history of the coal formations. Discoveries of nearly the same kind as those of Professor Dawson have been made lately both in Europe and in the United States. Goldenberg has found in the coal measures of the Vosges, in France, new species of *Blattinæ*, *Thermites*, *Dyctioneuron*, etc.,

and five wings of a *Blattina* have been lately found in the lowest coal of Arkansas. — *Silliman's Journal.*

Interesting Discovery of new Sauroid Remains in the Coal Formation of Nova Scotia.—Mr. O. C. Marsh, of New Haven, has recently procured from the coal formation of the Joggins, in Nova Scotia, two Saurian vertebræ, of which Agassiz writes as follows: — These two vertebræ have excited my interest in the highest degree. I have never seen in the body of a vertebra such characters combined as are here exhibited. At first sight they might be mistaken for ordinary Ichthyosaurus vertebræ; but a closer examination soon shows a singular notch in the body of the vertebra itself, such as I have never seen in reptiles, though this character is common in fishes. We have here undoubtedly a nearer approximation *to a synthesis between fish and reptile* than has yet been seen. . . . . The discovery of the Ichthyosauri was not more important than that of these vertebræ; but what would be the knowledge of their existence without the extensive comparisons to which it has led? Now these vertebræ ought to be carefully compared with the vertebræ of bony fishes, with those of sauroid fishes, of selachians, of batrachians, of the oolitic crocodilians, of the newer crocodilians, of the Ichthyosaurians, and of the Plesiosaurians, and all the points of resemblance and difference stated; because I do not believe there is a vertebra known thus far in which are combined features of so many vertebræ, in which these features appear separately as characteristic of their type. — *Silliman's Journal.*

DISCOVERY OF A BONE-BED IN THE SO-CALLED NEW RED SANDSTONE OF THE ATLANTIC STATES.

No question in American geology seems more difficult of elucidation than the age and geological position of the so-called "New Red Sandstone" of the Atlantic slope; some geologists referring it to the Oolitic or Liassic periods, others to the Trias, and others still lower, to the Permian. No true Permian forms (fossils) characteristic of that formation have yet been discovered, and the whole system is moreover destitute of beds of rock-salt and gypsum, which characterize mineralogically the Permian system, not only in Russia, but wherever else it has been recognized. During the past year Mr. Charles M. Wheatley has called attention for the first time to the existence of a bone-bed laid open by the excavation of a railroad tunnel in the shales and sandstones, of the same age as the so-called American New Red Sandstone, at Phœnixville, Pa. This bone-bed is about six inches thick, and contains abundant fragments of the bones of Saurians. Near the bone-bed is also a micaceous dolomitic sandstone, containing Saurian bones, *i. e.*, part of a jaw seven inches in length, with remains probably of batrachian animals, and the scales, teeth, and bones of ganoid fishes. So many teeth of Saurians, indeed, says Mr. Wheatley, have been collected and deposited in this dolomitic sandstone, that it has the appearance of an osseous (bony) conglomerate.

In some instances *the casts* only of the teeth remain, the substance of the tooth being converted into *dolomite*, but retaining the exact form of the tooth, with the sulcations as distinct as in the original;

twenty teeth of probably three or four genera of saurians, *all converted into dolomite*, occur on a piece of sandstone six by three inches. It is a singular fact that while the teeth are dolomitic casts only, the bones in the same stone remain unchanged, retaining their original structure.

Associated with the above fossils in the sandstone are numerous plant remains, mostly of a broad sulcated stem without joints or branches; as far as noticed they retain the same width their entire length, and are from one-half to two inches broad, and from six to eight inches long.

The shales, sandstones, and fossils of the Phœnixville tunnel bear a remarkable resemblance to those of Nagpur and Mangali, Central India, described by Messrs. Hislop and Hunter, *Journal Geological Society*, London, vols. x. and xi., and referred by them to the lower Jurassic age.

RELATION OF THE DILUVIAN OR QUATERNIAN PERIOD TO THE PRESENT OR MODERN EPOCH.

Although in all treatises on geology the Diluvian and the present or modern epoch are considered as distinct, it has nevertheless always been extremely difficult to fix the precise limit of demarcation between them. In the following article, translated for *Silliman's Journal* from the *Bibliothèque Universelle de Genève*, the celebrated geologist and palæontologist, M. Pictet, seeks to demonstrate that the Diluvian and modern epochs are really one, and that they ought to be so considered, and designated by a common name. For this purpose, he says, I shall first demonstrate that *all* actual and modern faunæ have existed from the origin of the Diluvian period. I shall next inquire what differences exist between the Diluvian fauna and the present fauna, and shall show that they consist only in the disappearance of a limited number of the larger species. For this purpose I have arranged a complete catalogue of the fauna of European mammifers, and I have inquired which have not been found in the fossil state, and what are those the bones of which have been found buried in the Diluvian beds, with the fossil elephant or with the cavern bear. Reasoning upon comparable and sufficiently certain facts, I have excluded from this list, —

1st. Marine mammifers, in view of the difficulty of determining the age of marine Quaternian deposits.

2d. Mammifers of remote regions, whose bones are not likely to be found in the more explored and better known Diluvian deposits of Central Europe. Thus, I have not considered as important either the monkey of Gibraltar, or the small species on the confines of Asiatic Russia, or those which have been recently discovered in Sicily or in Turkey. I have confined myself to those actually living in places where the Quaternian deposits are well known. Besides this, the excellent work of Eichwald proves the existence of the same state of things in Russia as in England, Belgium, France, Germany, or Switzerland.

The following are the principal facts obtained from an analysis of my catalogue, viz.: —

Almost all the common species of *Cheiroptera* have been found in the Quaternary deposits. It is probable that the rare species are wanting because we have not known how to distinguish their bones, or because they have not *yet* been found.

The same results are furnished by the *Insectivora.*

In these same Quaternary deposits are cited the hedgehog, the mole, and three or four species of the shrew-mouse.

The group *Rodentia* is of different determination, and we may naturally expect to find some vacancies, but there are none, however, of any importance. We may cite the squirrel, the marmot, the dormouse, the mouse, the hamster *(Crisetus)*, the water-rat, the ordinary meadow-mouse, the beaver, the hare, and the rabbit. The only striking vacancy will be that of the porcupine; but Mr. Areas has fortunately found this also in the caverns of Sicily. There are wanting to our list only some small species of the mouse, the garden dormouse, the muscardin, etc., in regard to which we may make the same reflection as was suggested by the Cheiroptera. The jerboa, lagomys, etc., are found as fossils in Russia.

The *Carnivora*, being in general larger than those animals which represent the preceding groups, and being at the same time more easily recognized, scarcely present any vacuity.

There have been found the lion, cat, wolf, domestic dog, fox, genet, white bear, brown bear, badger, glutton, martin, beech martin, polecat, ermine, weasel, and the otter. There is lacking to this list only the lynx, and it is important to know whether the *Felis engiholensis* of Schmerling, from the caverns of Belgium, is not identical with it.

The only *Pachyderms* of the present fauna yet found in our Quaternary deposits are three, — the wild boar, the horse, and the ass.

Among *Ruminants* have been enumerated all our present deer, the deer properly so called, the reindeer, the moose deer, and the roe-buck. The fallow deer is not comprised in this list, but, as is well known, it is not native in Central Europe. There are enumerated also the wild oxen (the urus and the bison), the chamois and the goat. The sheep had not been discovered until the last few years, which had probably been more recently imported; however, Mr. Areas has found in the caverns of Sicily a closely-related species, the *mufflon.* Finally, to this series of animals modern discoveries authorize us to add *man.* All this, as I have said elsewhere, appears to demonstrate that man has coëxisted with this Diluvian fauna, and that his history dates probably from the same epoch.

The facts here mentioned are remarkably conclusive, for they prove that all the present fauna of European mammifers have been found as fossils in the Quaternary deposits, except some small species difficult to be determined, the bones of which, if preserved, have not yet been recovered. It appears to me evident that these rare exceptions are without value as objections, and that we may boldly declare that, *from the commencement of the Diluvian period to the present day, no species of mammifers has been added to the fauna which then lived in Europe.*

What we have said of mammifers may also be affirmed of birds and reptiles; but upon this part of the subject I shall not enter into details, for these classes are less known, and do not furnish results so

certain. The examination of a treatise on palæontology is sufficient to show that the existing species are already indicated in the Diluvian deposits.

The terrestrial and fluviatile mollusks are in the same category. Thus with the bones of the *Elephas primigenius* are frequently found buried all our species of Helix, Bulimus, etc., and they show us that for the invertebrata, as well as for the vertebrata, all the existing fauna date from the origin of the Diluvian period.

The preceding facts suffice to show that there has been no renewal of the fauna between the Diluvian period and the modern epoch. We must now consider in what consists the apparent difference which has led most geologists into error. It has been caused by the gradual disappearance of a certain number of species. At the commencement of the Diluvian period the fauna was richer and more complete than it is at present. There lived in Europe at that time not only our present animals, but a certain number of species which are now extinct. These latter have gradually disappeared, from causes probably in part similar to those which destroyed one species of ox mentioned by Julius Cæsar, and which destroyed most likely the last representatives of the ure-ox (aurochs) and the elk. The fauna of the Eastern continent has been successively impoverished, and as the population and cultivation of the soil increased, only a part of the species which once dwelt there remain living.

It is not possible, in the present state of palæontology, to prepare a complete and precise catalogue of these extinct species; but it is sufficient for our purpose to sketch the principal features of such a catalogue.

I have experienced some doubt in regard to many races or species of true Quaternary deposits, indicated as different from those now living, but which have been characterized without doubt by their form, and not by appreciable organic characters. It appears to me quite natural that species at the commencement of the Diluvian epoch, finding abundant nourishment in a country where great forests and immense virgin territories replaced our present culture, and being able there to develop in freedom, should have frequently had a form a little superior to their existing representatives, which, surrounded by hunters, restrained on every side, lead a more difficult and precarious life. I do not think it possible to give a specific value to slight differences of stature, if all the other characters are identical, and therefore I consider as doubtful many of those species inserted in the catalogues of palæontology. Such are the *Talpa fossilis*, the *Meles Morreni*, the *Lutra antiqua*, the *Sciurus priscus*, the *Arctomys primigenia*, the *Myoxus fossilis*, the *Sus priscus*, etc. Some of these are probably identical with living species. By new researches we shall find that some of these are truly extinct.

But, aside from these difficulties and doubts, a certain number of species have certainly disappeared, which I will briefly enumerate.

In the family of *Bears* I consider as lost the great Cavern Bear (*Ursus spelæus*). Their bones characterize well the deposits called Diluvian, or the formations more ancient than the last period of our globe. The *Ursus priscus* is more doubtful, and is probably identical with our black bear. The *Hyenas* appear to have been represented

in the ancient epochs by three species which have now disappeared; the hyena of caverns is analogous to the spotted hyena of the Cape of Good Hope.

In the family of the *Felinidæ*, we should add to the wild-cat, the lynx (?) and lion, which have disappeared from Europe in the historic period, another species related to the leopard (*Felis antiqua*).

The numerous order of *Rodents* appear to contain some extinct species distinguishable from those now living.

The *Elephant* is one of the most remarkable of the genera among those which have made a part of the ancient fauna of our period. Their bones are, with those of the bear, the most characteristic of these Diluvian strata, since they are abundantly scattered over an immense surface of country. The species best known is the mammoth (*Elephas primigenius*). Of other bones may be mentioned those of the African elephant (*E. Africanus*). The existence of some other species is contested by some anatomists and admitted by others.

The great *Rhinoceros* with valved nostrils (*R. tichorhinus*), less widely diffused than the elephant, and probably also one or two species of the same genus, are striking examples of those races which have disappeared.

It is the same with the *Hippopotami*, of which it is thought we may admit the prior existence of many species now extinct.

The horse of Pézenas appears to be another species different from the one mentioned above as related to the existing horse.

The genus *Cervus* has been numerous from the commencement of the Diluvian epoch, for to the species now living, and which, as I have said, existed then, is to be added the beautiful giant stag of the peat bogs of Ireland (*Cervus euryceros*), the great deer of the Sômme (*Cervus dama giganteus*), and many species from caverns.

Among the other species of *ruminants* lost from our fauna, it is necessary to mention the *Antelope Christoli*, M. de Serres, the *Dichotoma*, Gervais, and *Ibex Cebennarum*, Gervais.

I will not add the *Bos primigenius*, because it was seen alive by Julius Cæsar.

I have not found among birds or reptiles any species to add with certainty to this list.

We shall find only a few in this category among the terrestrial invertebrata. The marine deposits on the borders of the Mediterranean contain some mollusks of lost species, but their numbers are small compared with species still living.

We thus see that the fauna originating at the period which succeeded the Tertiary epoch has been successively deprived of many remarkable species. This gradual disappearance may have proceeded from many natural causes. First, the climate, cooling very much, as the formation of great glaciers proves (Glacial period), would not be favorable to any one of them, especially to the great pachyderms, the congeners of which characterize in our day the torrid zone. Still more, as I have said elsewhere, admitting the presence of man from the origin of the latter period, we may, with much probability, attribute to him the destruction of a part of the species. If we examine the list which I have given, we shall see that, aside from

the great pachyderms, it is principally composed of carnivorous animals which man is interested to destroy, and of herbivora which should serve for his nourishment.

Mr. Lartet, in a memoir recently presented to the London Geological Society, has furnished a new argument in favor of this hypothesis. He has found marks of the instruments of man upon the bones of many species of this epoch, and in particular upon those of the ox and the goat; these marks being generally deep cuts designed to cause the rupture of the bone, sometimes mere superficial wounds, as if the object had been to elevate the skin about the base of the horns. This destruction of species is merely like that which daily transpires before our eyes. If new circumstances should cause the laws in regard to the chase to be abolished, and if the great landowners of Europe did not protect some species, it would not be long before all the deer of Europe would be classed among extinct species. They have already disappeared from many countries, and among others from the valley of the Rhone, where the stag and the roe-buck were abundant at the end of the last century.

A curious fact has been cited which seems to confirm what I have said; it is, the very limited number of species of small size, or little connected with the wants of man, among those which have disappeared.

Such is the opinion which has been formed in regard to the causes of this extinction. I repeat, therefore, that these causes can have no relation to those which acted during the previous periods, for in the renovation of the fauna there has always been a replacing of some species by others.

Here, on the contrary, we merely find extinctions, which can no more furnish a basis for distinguishing two periods than could the destruction of the *Bos primigenius* or that of the Dodo.

To complete our knowledge of the history of the Diluvio-modern period, it would be very interesting to ascertain the date of the extinction of each species. Some investigations of this kind have been recently undertaken, principally in England; but observers generally content themselves with stating the relation of bones to the Quaternary epoch without other details. It is important always, where it is possible, to determine accurately the position and the geological relations of the stratum which encloses them, and sometimes even to indicate whether they are found in the upper or the lower part of the stratum. It is important to examine with great care the bones in the deposits of the glacial epoch, for it is very probable that many species have extended even to that period. By such studies, well directed, we may obtain more accurate knowledge of this series of extinctions, and I doubt not we shall be more and more convinced that they have been gradual and successive.

ANTIQUITY OF MAN FROM THE EVIDENCE OF LANGUAGE.

The following paper on the above subject was read to the British Association, 1861, by Mr. Crawfurd: —

The periods usually assigned for man's first appearance on earth dated only from the time when he had already attained such an

amount of civilization as to enable him to frame some kind of record of his own career, and take no account of the many ages which must have transpired before he could have attained that power. Among the many facts attesting the high antiquity of man, the formation of language might be adduced, and his object was to give a few of the most striking facts which it yields. Language was not innate, but adventitious. Infants were without language, and those born deaf were always dumb, for without the sense of hearing there would have been no language at all. Among the unquestionable proofs that language was not innate, was the prodigious number of languages which existed, some being of a very simple and others of a very complex character. If additional evidence were wanted that language was an adventitious acquirement, it was found in this — that a whole nation might lose its original tongue, and in its stead adopt any foreign one. The language that had been the vernacular of the Jews for three thousand years had ceased to be so for two thousand years, and the descendants of those who spoke it were now speaking an infinity of foreign tongues, European or Asiatic. Languages which were derived from a single tongue of Italy had superseded the many native languages which were once spoken in Spain, in France, and in Italy itself. A language of German origin had nearly displaced not only all the native languages of England and Ireland, but the numerous ones of a large portion of America. Some eight millions of negroes were placed in the New World whose forefathers spoke many African tongues. It necessarily followed from this argument that when man first appeared on the earth he was destitute of language, and each separate tribe of men framing a separate one, hence the multitude of tongues. That the framers were arrant savages, was proved by the fact that the rudest tribes ever discovered had already completed the task of forming a perfect language. The languages spoken by the grovelling savages of Australia were so, and were even more artificial and complex in structure than those of many people more advanced. The first rudiments of language would consist of a few articulate sounds by which to make known their wants and wishes; and between that time and their obtaining completeness, probably countless ages had passed, even among the rudest tribes. In every department of language we find evidence of the great antiquity of man. The Egyptians must have attained a large measure of civilization before they had invented symbolic or phonetic writing, and yet these were found on the most ancient of their monuments. The invention of letters had been made at many different points, extending from Italy to China — a clear proof that civilization had many independent sources; but, such was everywhere the antiquity of the invention, that we could hardly in any case tell when or by whom it was made, though made in a hundred separate places. Epochs or eras, depending, as they must necessarily do, on the art of writing, were, of course, of still later origin. They were all, indeed, of comparatively recent origin. The Jews, Egyptians, Assyrians, and Persians had none at all; the Greek epoch dated only 776 and the Roman 753 before Christ. The oldest epoch of the Hindus made the world, and of course man, up to the present time, 3,872,960 years old. That was known to be a fable spun from faithless brains. The oldest era of the same people that

had an air of authority, that of the Buddha, dates 544 years before Christ. The era of Vikramaditza, of better authenticity, dates but 57 years before Christ; and that of Saka, probably more authentic, only 79 years later than our own. The Chinese mode of reckoning was by cycles of sixty years, making the first year of the first cycle correspond with the year before Christ 2397. Even this, if it could be relied on, would only carry us back to the time when the Chinese, a people placed, like the Hindus, under very unfavorable circumstances for development, had already attained a civilization which gave them the power of recording events, while it took no account of the long ages which must have elapsed before. After noticing the structure of various languages, and observing that there were many languages of simple structure, just as primitive as those of complex formation, the writer observed, that it appeared to him the structural character which languages originally assumed, would, in a great measure, be fortuitous, and depend on the whim or fancy of the first rude founders. Adam Smith, and he thought justly, supposed that the first rude attempts would consist in giving names to familiar objects, that is, in forming nouns substantive. Adjectives, or words expressing quality, as of a more abstract nature, would necessarily be of later invention; but verbs must have been nearly coeval with nouns; while pronouns he considered as terms very abstract and metaphysical, and as such not likely to have existed at all in the earlier period of language. "Number," Adam Smith said, "considered in general, without any relation to any particular set of objects numbered, is one of the most abstract and metaphysical ideas which the mind of man is capable of forming, and consequently is not an idea which would readily occur to rude mortals who were just beginning to form a language." And the truth of this view of the formation of numbers was corroborated by our observation of rude languages, in which the process seemed, as it were, to be still going on under our eyes. Among the Australian tribes, "two," or a pair, made the extent of their numerals. Other tribes had advanced to count as far as five and ten. Malayan nations had native numerals extending to a thousand. The two hands and the ten fingers seemed to have been the main aids to the formation of the abstractions which Adam Smith considered so subtle; and this would account for our finding the numeral scale sometimes binary, but generally decimal. However great the difficulty of constructing languages, there was no doubt they were all conquered, and that by rude savages; and the Sanskrit language, in all its complexity and perfection of structure, was spoken and written at least three thousand years ago, by men who, compared with their posterity, were certainly barbarians. The discovery of the art of writing implied an advanced state of civilization, the fruit of very long time; and from the sketch he had given of the formation of language, the conclusion was, he thought, inevitable that the birth of man was of vast antiquity.

THE FUTURE OF THE HUMAN RACE.

Many geologists and naturalists, including Agassiz, think that it can be shown by anatomical evidence that man is not only the last and highest among the living beings of the present period, but that he is the last term of a series, beyond which there is no material progress

possible in accordance with the plan upon which the whole animal kingdom is constructed, and that the only improvement we can look for upon earth, for the future, must consist in the development of man's intellectual and moral faculties.

There is, however, another side to this question, and the opposing view is well stated in the following quotation from Mr. Page's recent work, "*The Past and Present Life of the Globe.*"

"It is true that man at present stands the crowning form of vital existence, but the facts of the past give no countenance to the belief that he shall remain the crowning form in future epochs. From its dawn until now the great evolution of life has been ever upward, geologically speaking (and be it borne in mind we are treating the question solely from a geological standpoint): shall it not continue to be upward still? We see no symptom of decay either in the physical or vital forces of nature; and so long as these forces continue to operate, mutation and progress must inevitably follow. Man's own history, physical and moral, has been one of incessant change and progress. The features of different races, their mental qualities, civil systems, and religious beliefs, have all less or more partaken of this mutation; and the difference that now subsists between the most intellectual, city-dwelling, machine-making Anglo-Saxons and the men of the old flint implements and bone caves, may be infinitesimally small when compared with that which may exist between the noblest living nations and races yet to be evoked. Unless science has altogether misrepresented the past, and the course of creation as unfolded by geology be no better than a delusion, the future must transcend the present, as the present transcends that which has gone before it. Man present cannot possibly be man future. Noble as he may appear in his highest aspects, it were to limit creative power and arrest its progress to aver that man may not be superseded by another form still nobler and more divine. Physiologically, we cannot suppose that the homologies of the vertebrate skeleton have been exhausted in the structural adaptations of man; psychologically, we dare not presume against the correlation of a nobler intellect with a higher organization. On the contrary, in these ascending forms the divine idea of moral perfection, though inconceivably unattainable by created existences, may be nearly and more nearly approached, and stage by stage the loftiest and holiest aspirations of the present may become the realizations of the future. To speculations such as these, though lying fairly in the way of geological inquiry, science can do little more than merely indicate the line of reasoning; and if they shall be thought to involve any question as to man's religious beliefs and his hopes of a future life, on this point also science is mute, and defers with humility to the teachings of a higher philosophy."

CO-EXISTENCE OF MAN WITH THE EXTINCT QUADRUPEDS.

The following is an abstract of a communication recently read before the London Geological Society, by M. E. Lartet, "On the Coexistence of man with certain Extinct Quadrupeds, proved by Fossil Bones, from various Pleistocene Deposits, bearing incisions made by sharp instruments."

The author, having for some time past made observations upon fossil bones exhibiting evident impressions of human agency, was requested by the President, who had examined the specimens indicated, to communicate the results of his researches to this society.

The specimens referred to are: — 1st, fragments of bones of *Aurochs* exhibiting very deep incisions, made apparently by an instrument having a waved edge; 2dly, a portion of a skull of *Megaceros Hibernicus*, bearing significant marks of the mutilation and flaying of a recently slain animal. These were obtained from the lowest layer in the cutting of the Canal de l'Ourcq, near Paris, and have been figured by Cuvier in his *Ossem. Foss.* Molars of *Elephas primigenius* found in the same deposit are figured by Cuvier, who states that they had not been rolled, but had been deposited in an original and not a *remanié* deposit. 3dly. Among bones, with incisions, from the sands of Abbeville, are a large antler of an extinct stag *(Cervus somenensis)* and several horns of the common red deer. 4thly. Bones of *Rhinoceros tichorhinus* from Menchecourt, near Abbeville, where flints worked by human hands have been found. 5thly. Portions of horns of *Megaceros* from the British Isles. In reference to the remains of the gigantic deer, M. Lartet alludes to the statement, that stone implements have been found in the Isle of Man imbedded with remains of the *Megaceros*, and that hatchet-marks have been seen on an oak tree in a submerged forest of possibly still older date. 6thly. Fragments of bone collected by M. Delesse from a deposit near Paris, and exhibiting evidence of having been sawn, not with a smooth metallic saw, but with such an instrument as the flint knives or splinters, with a sharp chisel-edge, found at Abbeville would supply.

If, says the author, the presence of worked flints in the gravel and sands of the valley of the Somme have established with certainty the existence of man at the time when those very ancient deposits were formed, the traces of an intentional operation on the bones of *Rhinoceros*, *Aurochs*, *Megaceros*, *Cervus somenensis*, etc., supply equally the inductive demonstration of the contemporaneity of those species with the human race. M. Lartet points out that the Aurochs, though still existing, was contemporaneous with the *Elephas primigenius*, and that its remains occur in preglacial deposits; and, indeed, that a great proportion of our living mammifers have been contemporaneous with *E. primigenius* and *R. tichorhinus*, the first appearance of which in Western Europe must have been preceded by that of several of our still existing quadrupeds.

The author also remarks, that there is good evidence of changes of level having occurred since man began to occupy Europe and the British Isles, yet they have not amounted to catastrophes so general as to affect the regular succession of organized beings.

Lastly, M. Lartet announced that a flint hatchet and some flint knives had lately been discovered in company with remains of elephant, aurochs, horse, and a feline animal, in the sands of the Parisian suburb of Grenelle, by M. Gosse, of Geneva.

THE KJHÖHENMODDINGS OF DENMARK.

This term (derived from *Kjhohen*, kitchen, and *modding*, a refuse heap) is popularly applied to the very interesting deposits from which an immense number of archæological and natural history specimens have been obtained and placed in the celebrated Museum of Northern Antiquities at Copenhagen. Much attention has been of late years bestowed on the extensive peat bogs of Denmark, on account of the antiquities in which they abound, and for their bearing on geology. Prof. Steenstrap, the well-known naturalist, estimates that every col-

umn of peat three feet square contains some specimen of ancient workmanship. Mr. John Lubbock, of England, in a recent number of the *British Natural History Review*, gives a detailed account of the results of the investigations of Danish archæologists. In a recent visit by him to these ancient Danish dust heaps, many interesting specimens of animal remains, shells, bones, etc., were collected. Of human implements, they discovered flint axes, saws, chisels, etc., and small pieces of coarse pottery, etc. Numerous human skeletons were found in tumuli. The skulls were round, resembling those of the Laps. Mr. Lubbock considers that the country must have been inhabited several thousand years before the Christian era. He adds, no flint implements have yet been found in Denmark resembling those occurring in the drift near Abbeville and Amiens. Not only does the difference in workmanship, but also the absence of any trace of the elephant and rhinoceros with the human remains in Denmark, and their well-attested presence in France in the same strata with the flint implements, tend to prove the greater antiquity of the latter.

NATURAL DISSEMINATION OF GOLD.

Mr. Eckfeldt, the Principal Assayer of the United States Mint at Philadelphia, has lately made several interesting examinations tending to show the very wide distribution of gold. Passing over the evidence respecting its presence in various galenas, in metallic lead, copper, silver, antimony, etc., we cite the following, perhaps the most curious result of all. Underneath the paved city of Philadelphia there lies a deposit of clay, whose area, by a probable estimate, would measure over three miles square, enabling us to figure out the convenient sum of ten square miles. The average depth is believed to be not less than fifteen feet. The inquiry was started whether gold was diffused in this earthy bed. From a central locality, which might afford a fair assay for the whole, the cellar of the new market-house in Market Street, near Eleventh Street, we dug out some of the clay at a depth of fourteen feet, where it could not have been an artificial deposit. The weight of one hundred and thirty grammes was dried and duly treated, and yielded one-eighth of a milligramme of gold, — a very decided quantity on a fine assay balance.

It was afterwards ascertained that the clay, in its natural moisture, loses about fifteen per cent. by drying. So that, as it lies in the ground, the clay contains one part gold in 1,224,000. This experiment was repeated upon clay taken from a brickyard in the suburbs of the city, with nearly the same result.

In order to calculate with some accuracy the value of this body of wealth, we cut out blocks of the clay, and found that, on an average, a cubic foot, as it lies in the ground, weighs one hundred and twenty pounds, as near as may be, making the specific gravity 1.92. The assay gives seven-tenths of a grain, say three cents' worth of gold, to the cubic foot. Assuming the data already given, we get four thousand one hundred and eighty millions of cubic feet of clay under our streets and houses, in which securely lies one hundred and twenty-six millions of dollars. And if, as is pretty certain, the corporate limits of the city would afford eight times this bulk of clay, we have more

gold than has yet been brought, according to the statistics, from California and Australia.

It is also apparent that every time a cartload of clay is hauled out of a cellar, enough gold goes with it to pay for the carting. And if the bricks which front our houses could have brought to their surface, in the form of gold leaf, the amount of gold which they contain, we should have the glittering show of two square inches on every brick. —*Am. Phil. Society Proc.*

CLEAVAGE OF THE DIAMOND.

Although the diamond is so hard, it is very easily broken; and, indeed, by a particular knack, it may even be cut with a common penknife. This apparent anomaly is due to what is called its *cleavage*, a result of the crystalline structure. Many well-known substances — as slate, for example — split or cleave with peculiar facility in certain definite directions, while they offer considerable resistance to fracture in all others. The diamond has this property, cleaving easily in no less than four directions, parallel to the surfaces of the octohedric crystal; and, therefore, when moderate force is applied in either of these ways, the stone splits into pieces. Pliny, mentioning the great hardness of the diamond, states that if laid upon an anvil, and struck with a hammer, the steel would sooner give way than the stone. This assertion is a matter of popular belief in the present day, but we would not recommend any possessor of a good diamond to try the experiment. The chances of some of the forces acting in the cleavage directions are so great, that the stone would in all probability fly to pieces under the first blow. The truth is, that Pliny referred not to the diamond, but to the *sapphire*, which, though less hard than the diamond, cleaves only in *one* direction, and might, therefore, withstand the test named. The cleaving property of the diamond is made useful in two ways in the manufacture: first, by splitting the stones when they contain flaws, and, secondly, in the preparation of diamond powder. When a rough diamond is seen to contain a defect of sufficient extent to depreciate its value as a single gem, it is split in two, precisely at the flaw, so as to make two sound stones. This is a very simple operation in appearance, done in a few seconds, but it requires an amazing amount of skill to do it properly. The workman, by a sort of intuitive knowledge, gained by long experience, knows, on a careful inspection of the stone, the exact direction which a cleavage plane passing through the flaw will take. Tracing this plane, therefore, to the exterior, he makes on the edge of the stone, precisely in the same spot, a slight nick with another diamond. He then places a small knife in that nick, gives it a light tap with a hammer, and the stone at once cleaves in two, directly through the flaw. This operation, in daily practice in the Amsterdam diamond works, is one of the most elegant and instructive processes in the whole range of mineralogy. It is reported that Dr. Wollaston, celebrated as almost the originator of the science of crystallography, once made a handsome sum by purchasing a large flawed diamond, at a low price, and subsequently splitting it into smaller

sound and valuable stones, the principle of the operation not being then generally known.

CURIOUS MINERAL DEPOSIT IN NEW ZEALAND.

Ever since the settlement of New Zealand by Europeans their attention has been daily called to the peculiarities of a kind of metallic sand along the shores of New Plymouth, in Taranaki. This sand has the appearance of fine steel filings, and if a magnet be dropped upon it, and taken up again, the instrument will be found thickly coated with the iron granules. The place where the sand abounds is along the base of Mount Egmont, an extinct volcano; and the deposit extends several miles along the coast, to the depth of many feet, and having a corresponding breadth. The geological supposition is that this granulated metal has been thrown out of the volcano, along the base of which it rests, into the sea, and there pulverized. It has been looked upon for a long time as a geological curiosity, even to the extent of trying to smelt some of it; but, although so many years have passed since its discovery, it is only recently that any attempt has been made to turn it to a practical account; in fact, the quantity is so large that people out there looked upon it as utterly valueless. It formed a standing complaint in the letters of all emigrants that when the sea breeze was a little up they were obliged to wear veils to prevent being blinded by the fine sand which stretched for miles along the shore. Captain Morshead, resident in the West of England, was so much impressed with its value that he went to New Zealand to verify the reports made to him in this country, and was fortunate enough to find them all correct. He smelted the ore first in a crucible, and subsequently in a furnace; the results were so satisfactory that he immediately obtained the necessary grant of the sand from the government, and returned to England with several tons for more conclusive experiments.

It has been carefully analyzed by several well-known metallurgists, and has been pronounced to be the purest ore at present known: it contains 88.45 of peroxide of iron, 11.43 of oxide of titanium, with silica, and only .12 of waste in 100 parts. Taking the sand as it lies on the beach and smelting it, the produce is 61 per cent. of iron of the very finest quality; and, again, if this sand be subjected to what is called the cementation process, the result is a tough, first-class steel, which, in its properties, seems to surpass any other description of that metal at present known.

EVOLUTIONS OF AMMONIA FROM VOLCANOES.

At the last meeting of the British Association (1861), Dr. Daubury, in a paper on the above subject, stated that the phenomena had been ascribed by Bischof to the decomposition of bituminous waters by volcanic heat; by Bunsen, to the lava flowing over herbage and disengaging its nitrogen in the form of ammonia; and by himself, to the direct union of hydrogen and nitrogen in the interior of the earth under an enormous pressure. Now, however, that Wöhler has shown the affinity which subsists between nitrogen and certain of the metals

and simple combustibles, some of which, as titanium or boron, combine with it directly with such avidity that the union is attended with combustion, and has also proved that the nitrides formed are decomposed by the hydrated alkalies, ammonia being thereby generated,— it had occurred to the author that a more probable explanation of the occurrence of ammonia in volcanoes might be afforded by supposing such combinations to take place in the interior of the earth, and to be subsequently decomposed by the alkalies which are usually present wherever volcanic action is taking place. In confirmation of this view, he appealed to a late observation made at Naples, namely, that metallic titanium had been found evolved from the crater of Vesuvius, during a late eruption.

EARTHQUAKES AND VOLCANIC ERUPTIONS FOR 1861.

The most serious earthquake of the year occurred in the night of the 20th of March, overwhelming the city of Mendoza, in the Argentine Republic, South America. Mendoza is in lat. 32° 53′ S., lon. 69° 6′ W., and is about 2900 feet above the sea on the eastern slope of the Andes. The shock is said to have come from the north, followed by another from the south, and to have lasted only about five seconds, in which brief time nearly the whole town was utterly laid waste, and from 8000 to 12,000 lives were destroyed. Travellers among the Andes, in the district affected by the earthquake, describe the scene as awful: deep caverns were opened into the bowels of the mountains, the mountain summits parted asunder, and the earth in many places burst open like a bomb-shell, ejecting water and enormous stones.

The most important volcanic eruption of the year took place in an unusual locality, viz., on the east coast of Africa, on the 7th of May, from a heretofore unrecognized volcano at Djebel Dubbeh, situated in about 13° 57′ N. lat., and 41° 20′ E. long. It was accompanied by loud shocks, resembling the discharge of artillery, and immense clouds of dust. The noises were distinctly heard at places nearly 400 miles apart, and the dust fell for several days over a vast extent of the Red Sea, and on the coast of Arabia. At Edd, on the Abyssinian coast, a day's journey from Djebel Dubbeh, the dust was knee-deep, and its fall during the first day caused total darkness. The eruption continued at intervals for three or four days. There is no remembrance of any previous eruption.

Vesuvius has also been extremely active during the past year.

GEOLOGICAL SUMMARY.

Origin of Granite.—Interesting results of a microscopic examination of granite have recently been published by Mr. Sortby, F. R. S., of England. It appears that by reducing granite by grinding and polishing to extremely thin films, so as to render them transparent, like gold leaves, Mr. Sortby has discovered that this rock contains a large number of cells or cavities holding water or saline solutions; hence it may be inferred, to the great satisfaction of the Neptunians, that granite was not solely produced by the action of fire, but that water had a great deal to do with it.

Strange Illustration of the Movements of Glaciers.—Some of our readers have doubtless heard of the tragic end of Auguste Tairaz, Pierre Balmat, and Pierre Carrier, the three Chamounix guides who were swept from the Grand Plateau by an avalanche on Aug. 20, 1820, while making, or attempting, the ascent of Mont Blanc with Dr. Hammel and some Genevese gentlemen. No traces whatever of these poor fellows had been discovered from the moment of their destruction until within the past summer, when one of the bodies, imbedded in the ice, has been found on the lower part of the Glacier des Bossons entering the valley. Professor Forbes has repeatedly told the Chamounix guides that they might look out for traces of their deceased comrades in the Lower Bossons in about forty to forty-five years after the catastrophe. He told Auguste Balmat in 1858 to keep a lookout, as traces of the bodies might then be expected to present themselves from the glacier movement.

Glaciers of Spitzbergen.—Mr. Lamont, an English tourist, who has recently made a yacht voyage to Spitzbergen, thus describes a glacier seen by him upon the coast of that island:—"It is," he says, "the largest perhaps in the world. It has a seaward face of thirty to thirty-two English miles, and protrudes in three great sweeping arcs for at least five miles beyond the coast line. It has a precipitous and inaccessible cliff of ice all along its face, varying from twenty to one hundred feet in height; pieces from the size of a church downward are constantly becoming detached from this icy precipice, and tumble into the sea with a terrific roar and splash, and of course render it highly dangerous to go near the base in a boat. The surrounding sea is always filled with these fragments of all sizes and shapes, and many of them I have observed carrying large quantities of clay and stones imbedded in them.

"This great glacier is in three divisions. The northern and southern divisions are each quite smooth and glassy, but the piece in the centre is broken up and rough, and jagged to a degree that is perfectly indescribable; at a little distance it exactly resembles a great forest of pine trees thickly covered with snow.

"This part of the glacier must have undergone some great disturbance, arising either from its sliding over a rocky bed, or from its being forced through a narrow ravine in the underlying hills. Whatever the disturbing cause may be, it is actively at work still, because we frequently saw enormous slices of the smooth division split up and cave in toward the disrupted part; and there is a constant succession of tremendous booming reports, exactly resembling loud and prolonged thunder, proceeding from these cracks, and from the whole of the rough part of the glacier in general."

Elevations and Depressions of the Earth in North America.—Dr. Gessner, in a recent paper before the London Geological Society, after some observations on the differences between volcanic uplifts of the land and the slow upward and downward shiftings produced by changes in the position of great parallel areas during long periods of time, proceeded to enumerate evidences of local elevation and subsidence that he has observed along the coast from the northern part of Labrador to New Jersey.

In the south-eastern part of New Jersey, at Nantucket, Martha's

Vineyard, and Portland, submergence of the land is proceeding, locally, at the rate of probably four feet in sixty years. In New Brunswick, at St. John's, the land has been elevated; at the Grand Manan Island and the Great Tantaman Marsh, there has been subsidence. At Bathurst, and on the opposite coast of Lower Canada, the land seems to be rising. In Nova Scotia, near the Bay of Fundy and Mines Basin, there is subsidence; on the southern side, however, there are signs of elevation. The sea rapidly encroaches upon Louisberg, in Cape Breton; and in Prince Edward's Island, also, submergence of the land is taking place.

The Swiss Geological Strata in the form of C form the subject of an interesting paper recently published by Professor Strada, of Berne. He expresses the opinion that all the facts considered lead him to recognize an immense lateral force, the action of which has been propagated from the axes of the Central Alps to the borders of the chain. This force does not appear to be in direct relation to the granitic masses, but is rather due to the origin or enlargement of the crevasses of the earth's crust, by which all the zones of the Swiss Central Alps, composed of serpentine and metamorphic schist, etc., have been brought to light in the same manner as a button forces the sides of a button-hole when passed through it.

Rigidity of the Earth.—Dr. Joule, in a recent communication to the London Geological Society, in reference to speculations on the thickness of the earth's crust, stated that he had some time ago received a letter from Professor Thomson, giving an account of the progress of investigations calculated to throw light on this interesting subject. Professor Thomson finds that the equilibrium lunar tide in a solid glass globe, without mutual gravitation, of the same size as the earth, is about five feet. Hence, from the phenomena of the actual tides of the ocean, it follows that the earth, as a whole, is more rigid than glass. The observations of Mallet with experimental earthquakes show that the earth's crust is many times less rigid than glass. Hence Professor Thomson infers that the earth, as a whole, is many times more rigid than the rocks and strata on its surface.

Divisions of the Earth's Crust.—In a recent discussion in the Boston Society of Natural History, Professor Agassiz remarked that in late general works eleven or twelve subdivisions of the earth's crust are given; D'Orbigny makes twenty-seven; but he (Agassiz) was prepared to show the occurrence of at least forty-eight successive periods of change, with characteristic fossils found neither below nor above their respective beds; the alleged identity of fossils in different strata was only apparent, and would be found so on actual comparison of specimens.

In the tertiary, according to Mr. Lyell, four or five per cent. of the eocene species pass on to the present period, nineteen per cent. in the miocene, and about one-half in the pliocene; this he regarded as an error which would not have been committed with a sound zoölogist by his side. He instanced *Rostellaria fissurella*, which had been considered identical in several formations, as being easily recognized to embrace distinct species on actual comparison of the specimens. He objected to Deshayes's principle of requiring equal and great differences in the determination of species, as what would constitute a

specific difference in one case might be far greater than that required in another. The mastodon and *Elephas primigenius* are acknowledged to be extinct, and he saw no reason why other classes in the animal kingdom should not be exterminated by the same causes; he was convinced that careful examination would show that the lowest mollusks in the tertiary beds are as different from the present as are the larger animals.

The Great Falls of Zambesi, Southern Africa. — Dr. Livingston, in a recent letter to Sir R. I. Murchison, states that he greatly underrated, in his published "Travels," the magnitude of the Victoria Falls of the Zambesi River, which are probably the most wonderful in the world. Their breadth, which he had estimated at about one thousand yards, is now ascertained to be at least one thousand eight hundred and sixty yards, with a sheer fall of three hundred and ten feet.

Mineral Produce of Great Britain. — Sir R. I. Murchison, in an address before the geological section of the British Association, (1861), thus states the present yearly mineral production of Great Britain: —

"We are now consuming and exporting about 80 millions of tons of coals annually — a prodigious recent increase, and daily augmenting. Of iron ore we raise and smelt upwards of 8 millions of tons, producing 3,826,000 tons of pig iron. Of copper ore we raise from our own mines 236,696 tons, which yield 15,968 tons of metallic copper; and from our native metallic minerals we obtain of tin 6,695 tons; of lead, 63,525 tons; and of zinc, 4,357 tons. The total annual value of our minerals and coals is estimated at £26,993,573, and that of metals (the produce of the above minerals) and coals at £37,121,318!"

Tin Ore from Maine. — At a recent meeting of the Boston Society of Natural History, Mr. Verrill exhibited a piece of tin ore, from Mt. Mica, Paris, Me., which was part of a mass which originally weighed five pounds. He stated that he had also found several smaller specimens, some beautifully crystallized, scattered through the mass of rock constituting the vein; they were generally in contact with albite or quartz.

Auriferous Veins. — As respects auriferous veins, one tenet of geological science has received ample confirmation in Australian experience. Throughout the known world it has been found that auriferous veins are, as a general rule, only very rich near the surface. They decrease rapidly in richness as they increase in depth, which is not true of the veins of the baser metals. Now the colonists of Victoria would not give due heed to this dictum of science, but, believing the contrary, they commenced extensive works on nearly every lode which had proved rich near the surface, and intended to prosecute deep mining thereupon. Hence, in spite of science, a gold-mining fever arose, and unfounded speculation raged far and wide. The mining experience, however, of 1859–60 has warranted the truth of the scientific opinion, — or rather induction from numerous observations, — and has proved the folly of popular presumption. Not a tithe of the mining companies formed in 1859 are now in existence; and "there are not six quartz veins in the colony of Victoria in which a sufficient quantity of gold has been obtained, at a depth of four hun-

dred feet, to pay for the cost of extraction; while in every gold-field instances can be pointed to of mines, once worked with great profit, now deserted on account of the poverty of the deeper parts of the lodes."

Curious Mineral Formation. — Some ancient bronze implements recently dug up near Moskowie, in Bohemia, have obtained considerable celebrity, not only from archæologists, but from students of natural history, since on many of them different layers of malachite have been formed, from which an opinion may be arrived at of the continuance on them of the action of the carbonic-acidulated moisture. But still more interesting is the existence of the impression of a leaf upon one of the implements, showing the plainly indented outlines and filaments of one of the under sides of a leaf of the *Folium alpense* of Linnæus. The formation of such an impression on the perfectly even surface of the malachite was only possible whilst the malachite was forming as quietly as slowly, so that for every removed particle of bronze an atom of malachite was substituted. It must be assumed that it was only possible for such a process to have been completed in the slow progress of years — thousands after the instrument had proceeded from the hands of man. This implement is therefore of great importance for the archæologist, as it proves that instruments of bronze were used in middle Europe at an epoch stretching far beyond the period of historical research.

Remains of the Plesiosaurus from New Zealand. — At the meeting of the British Association, 1861, Prof. Owen stated that he had obtained evidence, in the form of bones, from New Zealand, that the Plesiosaurus existed in the mesozoic age, in the present region of the Pacific, as well as in the Northern Hemisphere.

Geology vs. Sugar Refining. — During the past year, in the vicinity of Tschernigoff, Russia, the complete skeleton of a large mammoth was discovered. Unfortunately for science, a sugar-refinery was in full play in the adjoining village, and the remains of the animal, which would have been the treasure of any museum, found a second grave in the bone-black furnaces of the manufactory. One tooth only found its way to the Imperial Museum of Moscow.

BOTANY.

HOW THE CHINESE MAKE DWARF TREES.

We have all known from childhood how the Chinese cramp their women's feet, and so manage to make them "keepers at home," but how they contrive to grow miniature pines and oaks in flower-pots for half a century has always been much of a secret. It is the product chiefly of skilful, long-continued root-pruning. They aim, first and last, at the seat of vigorous growth, endeavoring to weaken it as far as may consist with the preservation of life. They begin at the beginning. Taking a young plant (say a seedling or cutting of a cedar), when only two or three inches high, they cut off its tap-root as soon as it has other rootlets enough to live upon, and replant it in a shallow earthen pot or pan. The end of the tap-root is generally made to rest on the bottom of the pan, or on a flat stone within it. Alluvial clay is then put into the pot, much of it in bits the size of beans, and just enough in kind and quantity to furnish a scanty nourishment to the plant. Water enough is given to keep it in growth, but not enough to excite a vigorous habit. So, likewise, in the application of light and heat. As the Chinese pride themselves also on the shape of their miniature trees, they use strings, wires, and pegs, and various other mechanical contrivances, to promote symmetry of habit, or to fashion their pets into odd fancy figures. Thus, by the use of very shallow pots, the growth of the tap-roots is out of the question; by the use of poor soil, and little of it, and little water, strong growth is prevented. Then, too, the top and side roots, being within easy reach of the gardener, are shortened by his pruning knife, or seared with his hot iron. So the little tree, finding itself headed on every side, gives up the idea of strong growth, asking only for life, and just growth enough to live and look well. Accordingly, each new set of leaves becomes more and more stunted, the buds and rootlets are diminished in proportion, and at length a balance is established between every part of the tree, making it a dwarf in all respects. In some kinds of trees this end is reached in three or four years; in others ten or fifteen years are necessary. Such is fancy horticulture among the Celestials. — *Scottish Farmer*.

IMPORTANT USE OF SEAWEED.

M. E. Legou has presented a report to the Paris Academy of Sciences on the employment of seaweed, applied in layers against the

thin walls of habitations, to prevent sudden variations in and excess of temperature. The marine algæ, such as seawrack, may be termed a sea-wool, which has this advantage over ordinary wool, that it does not harbor insects, and undergoes no change by dryness or humidity, provided it be not exposed to the solar rays: in that case it undergoes a complete transformation — from being brown and flexible it becomes white and almost rigid. In the dark, on the contrary, it is unchangeable, unfermentable, imputrescent, uninflammable, and unattackable by insects. At first it has the objection of being hygromatic; but a single washing in fresh water removes the salt, and then its properties become so beneficial, that a celebrated architect has styled it the "flannel of health for habitations." It has been applied successfully between the tiles and ceiling of a railway station, also in a portable house intended for the use of officers at the camp of Chalons; also double panels, the intermediate space being filled with seaweed, have been prepared for the construction of temporary barracks at the Isle of Réunion. The Consulting Committee of Public Health, the Society of Civil Engineers, the Council for Civic Structures, etc., have expressed their approval of the judicious employment of the marine algæ, and state that the popularization of this process will be of great service in dwellings, especially in those of the humbler class, as it renders them both more agreeable and salubrious.

WHAT ARE JUTE AND GUNNY-BAGS?

The word "jute" is derived from the Bengalee term *Chuti*, which means false or deceptive, on account of the fibre having the appearance of beautiful silk when it is exposed to the sun for drying. It is the fibre of a plant which is very extensively cultivated throughout Bengal, and of which there are several varieties. One of these species furnishes the gunny so well known in commerce. The word "gunny" is a corruption of *Goni*, the native name on the Coromandel coast for the fibres of the *Corchorus Olitorius*. These fibres are made into the coarse cloth which we call gunny; also into cordage, and even paper.

Jute is indigenous to the soil of India, and has been cultivated by the natives for centuries. The manufacture of gunny-bags, or chutties, as they are called, gives employment to tens of thousands of the poorer inhabitants in Bengal. "Men, women and children," says Mr. Henley, "find occupation therein. Boatmen in their spare moments, husbandmen, palanquin-carriers and domestic servants — everybody, in fact, being Hindoos (for Mussulmen spin cotton only), pass their leisure moments distaff in hand, spinning gunny twist. Its preparation, together with the weaving into lengths, forms the never-failing resource of that most humble, patient and despised of created beings, the Hindoo widow. This manufacture spares her from being a charge on her family; she can always earn her bread. Among these causes will be discerned the very low prices at which gunny manufactures are produced in Bengal, and which has attracted the demand of the whole commercial world. There is, perhaps, no other article so universally diffused over the globe as the Indian gunny-bag. All the finer and long-stapled jute is reserved for the export trade, in which

it bears a comparatively high price. The short staple serves for the local manufacturers; and it may be remarked that a given weight of gunny-bags may be purchased at about the same price as a similar weight of raw material, leaving no apparent margin for spinning and weaving."

Dr. J. Forbes Watson states that 300,000 tons of jute are grown in India, of which upwards of 100,000 tons are exported as gunny-bags, besides 40,000 tons in the raw state. The production admits of unlimited extension.

The demand for gunny-bags is so great that a London company has established a large manufactory in Calcutta for their manufacture, and about £300,000 has been already expended. Immense numbers are used in the Bombay and Madras Presidencies, and in Penang, Singapore, Batavia, and the whole of the Indian Archipelago, for packing pepper, coffee, sugar, etc.; on the west coast of South America for nitrate of soda, borate of lime, regulus of silver, etc.; in the Brazils for copper and cotton, and in the United States for packing cotton; in fact, it is superseding all other materials for this purpose.

Each gunny-bag weighs on an average two pounds. Gunnies, or pieces of gunny cloth, are usually thirty yards long, and weigh about six pounds. From 6,000,000 to 10,000,000 gunnies, besides some thousand ready-made bags, are exported annually from India, chiefly to North America; 4,000 to 5,000 tons of fibre and rope made of sunn, a similar fibre, are also shipped yearly.

The whole supply of jute to this country comes to us through Calcutta. Cargoes are usually completed with it. It is used in every town in the United Kingdom, and for a great variety of purposes. It has long been extensively employed in the manufacture of coarse goods, such as cheap carpetings, bags, sacks, etc. The high price of flax of late years has also led to its extensive use in yarns hitherto purely flax or tow. It is mixed with the cotton warps of cheap broadcloths, and also with silk, and from its lustre can scarcely be detected. In Dundee, Scotland, especially, it is employed in the manufacture of many fine fabrics, and the quantity now imported into that place is estimated at 40,000 tons annually. The total imports of this fabric have increased rapidly of late years.

THE HEATHER A NATIVE OF THE UNITED STATES.

Quite a sensation has been created among botanists during the past summer (1861) by the discovery of plants of the Scotch heather (*Calluna vulgaris*) growing wild in the vicinity of Boston. It has been supposed that no true *Ericaceæ* were indigenous to America, though the large and highly ornamental family of *Ericaceæ* is abundantly represented by our beautiful native *Andromedas*, *Cassandra*, *Epigæa*, *Cassiope*, *Clethra*, and many other allied plants.

The only locality in which the heather has been found is in the town of Tewksbury, about five miles south-east of Lowell, and twenty miles north-west from Boston. Examination by Prof. Asa Gray and others seems to leave little room for doubt that the plant in this locality is indigenous, although the only one known in the United States. May not, however, the heather have once existed in pro-

fusion on this continent, and have gradually died out, owing to some inexplicable yet perhaps only slight climatic changes? May not this be the last vestige, or one of the last, of what was once an American heath? Every few years botanists are startled by the discovery in what were considered well gleaned localities of new or very rare plants, and we are forced to the conclusion that the botany even of New England and the Canadas is not yet wholly known. The botanical interest of this discovery is very great, not only from its unexpectedness, and from the new floral link by which it connects New England with the mother country, but also from its bearing upon mooted questions respecting the geographical distribution or dispersion of species, upon which distinguished naturalists are now at issue. — *Silliman's Journal, from a report to the Mass. Horticultural Society, by Edward S. Rand, Jr.*

BOTANICAL SUMMARY.

Substitute for Gutta Percha. — At a late meeting of the French Academy of Sciences, M. Serres gave an account of the *balata*, a shrub which abounds in Guiana, and affords a juice which he asserted was superior, for many purposes, to gutta percha, but especially as an insulating material for enveloping telegraphic wires. The milk or juice is drinkable, and used by the natives with coffee; it coagulates quickly when exposed to the air, and almost instantaneously when precipitated by alcohol, which also dissolves the resin of the *balata* juice. All the articles made with gutta percha can be made with the sap of the *balata*, and it has no disagreeable smell. When worked up it becomes as supple as cloth, and more flexible than gutta percha. M. Serres exhibited a number of articles manufactured of *balata* milk. Up to the present time it seems from M. Serres's account not to have become an article of commercial export.

New Canadian Dye. — Professor Lawson recently exhibited before the Botanical Society of Canada some specimens of a new dye of great richness, prepared in the laboratory of Queen's College, Kingston, from an insect, a species of coccus, found for the first time last summer on a tree of common black spruce in the neighborhood of Kingston. This dye closely resembles the expensive cochineal (produced in warm countries only), which is used for dyeing wool and silk a permanent red, crimson, or scarlet. Unlike cochineal, the new dye is a native Canadian product, and capable of being produced in temperate countries. Having been but recently discovered, a sufficient quantity has not been obtained for a complete series of experiments as to its nature and uses; but the habits of the insect, as well as the properties of the dye, seem to indicate that it may become of practical importance. In color it closely resembles ordinary cochineal, having rather more of the scarlet hue of the flowers of *Adonis autumnalis*, and no doubt other shades will be obtained.

The yearly Production of Nicotine in Tobacco. — It is stated that the tobacco crop of the world is 250,000,000 kilogrammes (=5,512,500 lbs. av.). Schlosing found in various tobaccos an average of about five per cent. of nicotine. It is clear, therefore, that about twelve and a half million of kilogrammes (=2,756,250 lbs.) of this poison are annually produced. As the specific gravity of nicotine very slightly

exceeds that of water, this quantity would fill nearly one hundred thousand wine barrels, and would give twelve and a half grammes (=293.025 grains) to every man, woman, and child on the globe. As a few drops will produce death, it is probably much within the mark to say, that one year's crop of nicotine could destroy every living creature on the face of the globe if its proportion was administered in a single dose.

Effects of Narcotic and Irritant Gases on Plants.—Mr. Livingston, an English chemist, after detailing several experiments on plants with sulphurous acid, hydrochloric acid, chlorine, sulphuretted hydrogen, ammonia, nitrous oxide, carbonic oxide, and coal gas, remarks: "It will be evident from the preceding experiments that gases divide themselves into two classes as regards their action on plants, namely, into narcotic and irritant gases. This distinction, to whatever cause traceable, is as real in the case of plants as in that of animals. When subjected to the influence of a narcotic gas, the color, it was observed, never became altered, and the plants looked as green and succulent at the end of the experiment as at the beginning. Whenever the plant began to droop, though removed to a forcing-bed and watered, in no instance did it recover, but died down even more speedily than it would have done if left to the continued action of the gas. In one word, narcotic gases destroy the life of the plant. With irritant gases, on the other hand, the action is more of a local character. The tips of the leaves first begin to be altered in color, and the discoloration rapidly spreads over the whole leaf, and, if continued long enough, over the whole plant; but if removed before the stem has been attacked by the gas, the plants always recover, with, however, the loss of their leaves. In a short time they put out a new crop, and seem in no way permanently injured; but of course, if repeatedly subjected to an atmosphere of irritant gas, the plants were destroyed."

Fruit Printing.—At Vienna, for some time past, fruit-dealers have sold peaches, pears, apples, apricots, etc., ornamented with armorial bearings, designs, initials, names, etc. The impression of these things is effected in a very simple manner. A fine fruit is selected at the moment it is beginning to ripen, that is, to take a red color, and paper, in which the designs are neatly cut out, is affixed. After a while the envelope is removed, and the part of the fruit which has been covered is brilliantly white.

The Camphor Tree.—R. C. Kendall writes to the *Working Farmer* that this valuable tree can be as easily cultivated in the United States as elsewhere. It is quite as hardy in its habits as any of our apple-trees. There is perhaps no reason why it should not succeed well wherever the apple-tree will grow. It is indigenous to all parts of China, Japan, Formosa, Burmah, Chinese Tartary, and flourishes even as far north as the Amoor country; but is found in the greatest abundance along the eastern coast of China, between Amoy and Shanghae. In the districts of Kwangtung and Fuh-hien, it grows in dense forests, the trunks attaining a size equalling that of any of our North American forest trees. The camphor gum of commerce does not in any case exude from the tree, as has been so generally supposed, but is obtained from the leaves, twigs, and smaller roots, by distillation. Like all other highly aromatic seeds, those of the Laurus

camphora very soon lose their vitality, and it is doubtful if they would germinate after the lapse of time requisite to bring them to this country; but as the tree itself is so tenacious of life that to kill it is a semi-impossibility, and as fine healthy plants are always readily obtainable at Hong Kong or Amoy, there would be no difficulty in introducing them here.

Insect Powder. — Persian Insect powder, which, when originally introduced, consisted of the flower buds of *Pyrethrum carneum* and *P. roseum*, as it occurs now consists in nine-tenths of the buds of *P. corymbosum* W., the remainder being made up of other Pyrethra, *P. tenuifolium*, or a variety of the *P. corymbosum*, partly of a Caucasian variety of *Anthemis arvensis.*

Similar properties belong to the flowers of *Anthemis nobilis, Matricaria chamomilla, Achillea nobilis, Pyrethrum tanacetum*, though in a smaller degree. The age of these powders has great influence on their efficacy; they should always be as fresh as possible.

Preservation of Cut Flowers. — A recent English horticultural writer gives the following information for prolonging the beauty of cut flowers: —

"For keeping flowers in water, finely-powdered charcoal, in which the stalks can be stuck, at the bottom of the vase, preserves them surprisingly, and renders the water free from any obnoxious qualities." When cut flowers have faded, either by being worn a whole evening in one's dress, or as a bouquet, "by cutting half an inch from the end of the stem in the morning, and putting the freshly-trimmed end instantly into quite boiling water, the petals may be seen to smooth out and to resume their beauty, often in a few minutes." Colored flowers, carnations, azaleas, roses, and geraniums, may be treated in this way; white flowers turn yellow; the thickest textured flowers amend the most, although azaleas revive wonderfully. "I have seen flowers that had lain the whole night on a table, after having been worn for hours, which at breakfast next morning were renovated by means of a cupful of hot water." Carnations and some others "keep fresh after this treatment almost as long as they would have done if they had been newly gathered."

Benzine (Benzole) for Plants. — The London *Gardener's Chronicle* gives the following advice respecting the destruction of insects on plants: "As our houses and gardens are always more or less infested with vermin, it is satisfactory to know that benzine, an article become sufficiently well known as a detergent, is no less efficacious as an agent in insecticide. One or two drops are sufficient to asphyxiate the most redoubtable insect pest, be it beetle, cockchafer, spider, slug, caterpillar, or other creeping things. Even rats and mice will speedily decamp from any place sprinkled with a few drops of the potent benzine.

To check the Warping of Planks. — The face of the planks should be cut in the direction which lay from east to west as the tree stood. If this be done the planks will warp much less than in the opposite direction. The strongest side of a piece of timber is that which in its natural position faced the north. — *Dingler's Polytech. Jour.*

The Woods best suited for Ship-Building. — At the last meeting of the British Association (1861), Professor Calvert stated that he had

recently made investigations into the qualities of several woods to ascertain which was the best for ship-building purposes. "If English oak," he said, "has hitherto stood so high, it must have been owing to our ignorance of the valuable properties of some of the woods grown in tropical climates, in which the soluble and highly decomposable tannin of oak is replaced in some instances by resins, and in others by substances similar to caoutchouc. This is the case with East Indian teak, Mora wood, Santa Maria and Honduras mahogany, which give them great advantages over oak when used for ship-building."

The liability of different woods to dry-rot were arranged by Dr. Calvert as follows: Unseasoned oak, rapid; seasoned, moderately rapid; African teak and Honduras mahogany, limited; Mora wood, Santa Maria mahogany, and Indian teak, no tendency whatever to dry-rot.

It was also observed by Dr. Calvert that oak which was felled in summer contained but little tannin and a great deal of gallic acid, while that felled in winter was rich in tannin and contained very little gallic acid.

Iron as a Tonic in Horticulture.— According to a Belgian horticultural paper, a Mr. Dubreuil, acting upon the experience that the leaves of a plant may be stimulated into a luxuriant growth by being moistened with a solution of copperas, applied a weak solution of this salt (half a drachm to a quart) to various kinds of fruit at a time of day when the same could not be reached by the rays of the sun, and at three different periods before their maturity. The first so treated are said to have grown to an extraordinary size.

White Flowers.—M. Filhol, the celebrated French chemist, in a paper on the coloring matter of flowers, states that there are no flowers of a pure white existing. The celebrated painter Redout noticed this a long time since. Flowers which appear to us white have nearly always a light-yellow, rose-colored, or blue tint. All these flowers become of a fine yellow when dipped in ammonia. Acids restore their primitive color.

PERENNIAL COTTON.

Mr. R. C. Kendall, of Maryland, in a recent pamphlet, calls attention to the existence, in Chili, S. A., of a species of cotton-bearing plant or tree, perennial in its nature, and capable of being grown with profit wherever Indian corn will ripen. His first acquaintance with the plant or tree in question was made while exploring the course of a little mountain stream, the Chipura, in Southern Chili. He says:—"Doubling an abrupt turn in the course of the river, I came suddenly into full view of an object, some two hundred yards distant, which presented the most magnificent spectacle I had ever seen—a perfect cone or pyramid of pure, brilliant snow, elevated at its base perhaps seven feet from the ground, upon a shaft of whitish bronze; the whole structure cut clear and sharp against the dark wall of rock in the background. It resolved itself, as I drew near, into a most perfect specimen of the *Gossypium arboreum*, the perennial cotton-tree. Its foliage had long been shed, but the pods remained, having fully burst, and turned out their spotless samples in almost perfect

roses, covering the entire structure with a dense mass of spotless, glossy cotton." The amount of cotton contained upon that single tree Mr. Kendall estimates at not less than one hundred pounds.

Further investigations showed that the species of *gossypium* in question was widely distributed, and in general possessed the following characteristics: — In its native condition, and in high southern latitudes, its average size and altitude equal the medium peach tree of North America — say eight inches in diameter at two feet from the ground, and in height twenty feet; in its general structure more nearly resembling the white mulberry than any other tree with which I am familiar. The leaves are abundant, distinctly denticulated, and of a glossy, silvery green. Flowers profuse, very double, variegated, and in size about a third smaller than the perfected hollyhock, the tree, when in full bloom, presenting one of the most beautiful effects imaginable. The bolls at maturity are twice the size of those borne by the herbaceous plant, and wherever it approached the colder regions, I found the fibre finer, and the length of staple increased.

The perennial cotton-tree is propagated from seed, or more readily from cuttings simply thrust into the ground, and possesses this peculiar advantage in any country over the herbaceous plant. It may be planted out as an apple, peach, or pear orchard, and the field cropped with any of the cereals, until the tree has reached its maximum standard. I found, says Mr. Kendall, the finest specimens of the tree, bearing cotton of the longest staple and whitest, finest fibre, in a region where the snow lies three months out of the twelve; where the vicissitudes of climate are greater than they are in New England; and where not only the natives, but the furred animals, sometimes freeze to death. On the Atlantic side, the *Gossypium arboreum* grows spontaneously, and entirely hardy, as high as the parallel of forty-two degrees. That the tree readily adapts itself to all reasonable and very many unreasonable conditions of soil and climate, is conclusively proved by the fact of my having found it growing bravely at an altitude very nearly approaching the snow-line, on the eastern slope of the Bolivian Andes, in a soil as red with peroxide of iron as a well burnt brick, and almost as hard. In the Desert of Alcamaya, I found it growing most determinedly in a bed of volcanic scoria, where never a drop of rain falls. In the vicinity of Arica and Tacna, in Peru, it thrives and produces cotton, growing in a waste of arid, burning sand. Everywhere in the low countries of the tropical regions, both the tree and staple degenerate; the former, in all cases, into a shrub, of from nine to twelve years' duration; the latter always into a coarser, shorter, and, under many conditions, into a material of no commercial value.

SKELETON LEAVES.

Mr. Edward Parish, of Philadelphia, the well-known pharmaceutist, publishes the following account of the process of producing the permanent and beautifully white preparations of the frame-work or skeleton of different vegetable structures, known as "skeletonizing." It consists in promoting the decomposition of the cellular structure of leaves, and other parts of plants, without breaking or injuring their

woody fibre, and is accomplished very easily and cheaply by macerating them in water. For convenience of illustration, let us select the seed-vessels or burs of stramonium or Jamestown weed, which are in the right condition when partially open, but not at all, or very slightly, when dried or faded in color. Place these in a basin or bucket, and pour on them sufficient hot water to cover them completely, and set them aside. (Cold water will answer the purpose, but not so quickly.) After about three weeks, during which time a little fresh water may be occasionally added, these will be softened, and ready for the removal of the cellular portions. This is accomplished by scrubbing with an old tooth-brush or shaving brush, allowing a stream of water to run over them during the process; the seeds are to be taken out, and the water allowed to run through the bur, but without removing the internal structure in which the seeds are deposited. In this way a perfect skeleton may be produced, showing all the woody portions, including the external prickles, and when bleached having the appearance of delicately carved ivory.

A variety of seed-vessels may be prepared in this way, of which the dried poppy-head is one of the prettiest. The internal membraneous portion containing the seeds requires to be removed, after the requisite maceration in water, by a small opening in the side. An offensive odor, arising from the decomposition of the cellular structure and its contents, is one of the discomforts of this process, but it is amply repaid by the beautiful resulting skeletons. In English "bouquets" of these preparations, there are some seed-vessels not often met with in this country, of which the henbane (hyosciamus) is beautiful.

The preparation of leaves affords a greater variety of forms than of any other portion of the plant. Only the leaves of trees and shrubs, as far as I know, will furnish a skeleton; those of annual and herbaceous plants seem to lose their structure entirely by maceration. Some of the more transparent and delicate leaves and ferns may be bleached by being put into the bleaching solution without previous maceration, but must always be previously faded. Among the best leaves for skeletonizing are those of the ivy, the linden, the elm, the poplar, the holly, the pear tree, the chestnut, the sassafras, the magnolia, the althea, and no doubt hundreds that have never been tried; the oak would furnish a beautiful skeleton, but requires from eight to twelve months' maceration, while most of the others named are sufficiently decayed in from one to three months. The leaves should be free from insect bites or other imperfections; in cleaning them, it is best to lay them upon a smooth board, turning them over, from time to time, and very carefully removing the decayed parts with a soft brush. It has been observed that ivy leaves are best prepared, after maceration, by tearing off the two outer layers of skin, leaving little else but the skeleton, which is then easily cleaned by careful handling under water. After obtaining the skeletons, the next step is to bleach them; this is done by placing them, for a term varying from an hour to a whole day, in a solution of chloride of lime, made by dissolving about two ounces in a pint of water. Poppy-heads or Jamestown burs will bear double that strength; some delicate leaves, hydrangea flowers, etc., will bleach advantageously with a still weaker solution. The preparation is to be removed from the bleaching liquid as soon

as it is thoroughly and satisfactorily bleached; it is then to be washed, dried, and put away in a box, excluded from the light, till the collection is ready for mounting. This operation requires much skill and taste; a common way is to make a kind of pin-cushion, into which the bleached stems or petioles, or covered wires glued to the base of the leaves and seed-vessels, are to be stuck; the whole may then be covered by a glass shade, which protects "the bouquet" from the dust, and renders it an exceedingly attractive household ornament.

ZOÖLOGY.

INSECT AND GRAIN EATING BIRDS.

Tourists in Europe will, if they are but commonly observant, notice one peculiar feature in Continental scenery, and especially in the scenery of France. The landscapes may be beautiful, and diversified by every possible charm, but in one particular respect they will be found almost utterly devoid of life. Eye and ear are struck together by the absence of familiar sights and familiar sounds. There is no chirping in the hedgerows, no twittering among the trees, no congregation of sparrows in the roads or linnets in the fields. It is useless to look about for the rarer species of birds, as even the commonest sorts are absent, and the traveller is perplexed to think what can have become of all the little creatures which he is accustomed to associate with rural scenes. The truth is very soon told. The French eat them. They pursue them unremittingly for the sake of their morsels of flesh, and a small bird seen in a garden would be chased as eagerly as a rabbit or a hare. Traps are systematically set for them on every eminence, and snares on every hedge. There is an idea, too, that birds destroy fruit, and economists will not submit to any such peculation; but the first is the principal motive, combined, perhaps, with an instinctive passion for the chase, which in France admits of little better gratification.

Little birds, however, are not sent into the world for nothing. Under the mission of Providence they, like all other creatures, contribute their part towards the harmony of creation, and when that contribution is intercepted the effects become visible in a derangement of balance. Birds devour insects, worms, and grubs. Where there are no birds, grubs, worms, and insects multiply to a prodigious extent, and where this unnatural multiplication takes place the crops suffer. During the past year (1861), the harvests of France have given an unusually poor return, and this deficiency is attributed in a great degree to the ravages of certain insects, which it is the function of certain birds to destroy. The subject has even attracted the attention of the French government, and, at the instance of the minister of agriculture, a commission was appointed to inquire into the matter, and report what legislation is expedient.

From a preliminary report emanating from this committee, it appears that their inquiries have been conducted with an elaborated accuracy characteristic of French legislation, and that the most experienced naturalists in France (M. St. Hilaire, M. Prevost, etc.) have

lent the aid of their experience to the investigations. Insects and birds have been carefully classified according to their several species; their habits of feeding have been closely observed, and the results ascertained and computed. It has been concluded that by no agency save that of little birds can the ravages of insects be kept down. There are some birds which live exclusively upon insects and grubs, and the quantity which they destroy is enormous. There are others which live partly on grubs and partly on grain, doing some damage, but providing an abundant compensation. A third class, the birds of prey, are excepted from the category of benefactors, and are pronounced — too precipitately, we think — to be noxious, inasmuch as they live mostly upon the smaller birds.

If the arrangements of nature were left undisturbed, the result would be a wholesome equilibrium of destruction. The birds would kill so many insects that the insects could not kill too many plants. One class is a match for the other. A certain insect was found to lay 2,000 eggs, but a single tomtit was found to eat 200,000 eggs a year. A swallow devours about 543 insects a day, eggs and all. A sparrow's nest in the city of Paris was found to contain 700 pairs of the upper wings of cockchafers, though, of course, in such a place food of other kinds was procurable in abundance. It will easily be seen, therefore, what an excess of insect life is produced when a counterpoise like this is withdrawn; and the statistics collected show clearly to what an extent the balance of nature has been disturbed. Thus, the value of the wheat destroyed in a single season, in one department of the east of France, by the *cécidomigie*, had been established at four millions of francs. The French vines, olives, and even the forest-trees, are also reported as suffering severely from the superabundance of insect vermin; so that, in consequence of the alarm occasioned, birds are likely to be hereafter protected in France without much legislation, and, indeed, their rise in estimation has been signally rapid. Some philosopher has declared, and the report quotes the saying as a "profound" one, that "the bird can live without man, but man cannot live without the bird."

This is a splendid confession of past error; but what is to be done, seeing that the convictions of philosophers have not yet descended to the peasantry? Are sparrow-catching and birds'-nesting to be made punishable? Must there be a new system of game laws for the protection of sparrows and linnets? The question is really pressing. Yet the commissioners, though they distinctly call for "prompt and energetic remedies," and point to the great detriment which agriculture is receiving, are evidently doubtful as to the course to be pursued. They suggest, however, that persuasion should be tried before coercion, and that schoolmasters and clergy should endeavor to put the question in its proper light before the people. The commission in their report present some curious statistics respecting the extent to which this destruction of birds in France has been of late years carried. They state that there are great numbers of professional huntsmen who are accustomed to kill from 100 to 200 birds daily. A single child, also, has been known to come home at night with 100 birds' eggs, and it is calculated and reported that the number of birds' eggs destroyed annually in France is between 80,000,000 and 100,000,000. The re-

sult is, as might have been expected, that little birds in that country are actually dying out; some species have already disappeared, while others are rapidly diminishing.

TYPICAL FORMS OF BIRDS.

At a late meeting of the Boston Society of Natural History, Mr. Theodore Lyman read a paper on the forms of birds, the object of which was to show how form, as depending on structure, may be recognized in this class, and may be expressed by measurements. He had compared, for this purpose, a hawk and an owl, and a duck and an auk, showing that the form is characteristic in each group, which may therefore be looked upon as a natural family in the animal kingdom. There is no essential difference between the bill and claws of the hawk and owl; there are, however, very striking differences in the size and position of the eyes, the bulk of the lower body, and in the length of the tarsus. Owls have large, prominent eyes, turned to the front, a body bulky below, and generally a very short tarsus; their abundant plumage is so arranged as to bring out these features; the feathers of the head make a kind of face, in the midst of which appear a half-buried beak and a pair of round, staring eyes; the body is large and heavy-looking, growing larger below, and apparently ending in a partly concealed pair of feet; the natural position is bolt upright, on account of the short tarsi and the weight of the body in front. Hawks have eyes of moderate size, rather sunken, and on the sides of the head; the body is elegant and compact, and the tarsus generally long; the plumage is commonly shorter and closer; the ordinary position is with the body standing well up on the legs, and inclined at a small angle from vertical. The owl gives the idea of solemnity and gravity, the hawk that of alertness and vigor, but both share the expression of ferocity.

In the auks and ducks, both water-birds, the chief elements of difference are the plane of the bill with reference to that of the head, the shape of the body, and the position of the legs. The ducks have the bill flattened in a horizontal and the head in a vertical plane, and the legs placed so far forward that they can move, though awkwardly, on land; the neck is long and slender, and the body short and chubby. The auks have the head compressed in a horizontal and the bill in a vertical plane; the body is very long and flattened vertically; the legs are entirely behind, and the tibia is so bound down by the integuments, that the animal, on land, often tumbles forward, and assumes when standing an upright position.

THE HOME OF THE PETRELS (MOTHER CAREY'S CHICKEN).

At a recent meeting of the Boston Society of Natural History, Dr. Bryant communicated the following notice of a visit to Green Island, some ten miles out at sea, off the mouth of Chester Bay, Nova Scotia, by the Rev. J. Ambrose, of Halifax.

On June 28, 1860, he landed on the north side of the island. Not a puffin or any other kind of bird was to be seen, save a large number of "steering" gulls and some "mackerel" gulls flying overhead,

whilst the whole island under foot was perforated and undermined by the petrels. He says: —

"I first took a tour all around the grassy edge of the cliffs to look for gulls' eggs. I got two dozen of the 'steering' gulls' eggs, and the men eight dozen. Tore up the turf with my hands, following the little galleries with my fingers, and soon secured four dozen and a half of petrels' eggs, and two of the parent birds as specimens. I could have obtained, I suppose, a thousand dozen of the eggs if I had wished, and every mother bird with them, as the poor little things crowd back into their holes, making not the slightest noise or resistance, whilst they behold the roof rudely torn from their dwelling, and their eggs taken away. In no instance, except one, did I find more than one egg in a nest, and in that there were but two; and yet some of the birds were hatching, as some of the eggs contained the embryo with its head and body so far developed as to clearly identify the species. The smell of the birds is at first very offensive; indeed, we perceived it at a distance of two miles from the island. This smell is not occasioned by any decayed fish or other extraneous matter, as the nests and surrounding turf are invariably very clean, the nest itself being lined at the bottom with a very little dry fine grass. The odor is peculiar to the bird and its egg, and is particularly perceptible in the dark brown oily fluid which, seemingly in self-defence, these birds eject from their bills.

"The sun was just rising when we landed on the island, and although we had seen several petrels flying about the boat in the night and at dawn of day on our passage, yet on the island not one was to be seen. All were under ground, where at first you could hear their twittering, as if arranging about nests and accommodations; but soon after sunrise they became almost entirely silent, at least so far as the screaming of the gulls, which was always about the same, would allow you to judge. On taking a petrel out of its nest, it would not on being set down attempt to fly at first, but would endeavor to dig its way down into some of the broken holes. Most of the nests seemed to be old ones newly fitted up, and I found several such where the bird had brought quite a sprinkling of fresh dirt out to the surface. They seem to form their galleries not so much by carrying out the surplus dirt, however, as by pressing themselves through the soft, turfy soil. A great many ants had made their nests among the galleries, but did not seem to incommode the birds; perhaps, indeed, they serve them for food at times."

ORNITHOLOGICAL CLOCK.

As botanists have constructed a flower-clock, so (we read in the foreign journals) a German woodsman has recently invented an ornithological clock, by marking the hours of the waking and the first notes of the little singers. The signal is given by the chaffinch, the earliest riser among all the feathery tribes. Its song precedes the dawn, and is heard in summer from half-past one to two o'clock, A. M. Next, from two to half-past three o'clock, comes the black-cap (*Sylvia atricapilla*), whose warblings would equal those of the nightingale if they were not so very short. From half-past two to three o'clock the quail

is heard. From three to half-past three the hedge-sparrow. Then, from half-past three to four o'clock, we have the blackbird, the mocking bird of our climates, which imitates all tunes so well, that M. Dureau de La Malle made all the blackbirds of a French canton sing the Marseillaise hymn, by letting loose a blackbird which had been taught that tune. From four to half-past four o'clock the lark pours forth its melodies; from half-past four to five o'clock the black-headed titmouse is heard. Lastly, from five to half-past five o'clock, the sparrow, the *gamin* of the skies, awakes and begins to chirp.

THE ORNITHORHYNCHUS OF AUSTRALIA.

Perhaps the greatest curiosity to be found in the rivers of Australia is the Ornithorhynchus paradoxus, or Water Mole, which is described by Dr. Bennett as forming a connecting link between the quadruped, the bird, and the reptile. When first a preserved skin of the animal was sent to England, it was looked upon as a clever fraud, but the proof of its genuineness soon became too strong to be resisted. Dr. Bennett, an English physician, who enjoys the honor of being the first naturalist who explored the burrow of this singular animal and captured specimens alive, has recently published a very graphic and interesting account of his experience in the attempt to rear and domesticate them. He says: — "I arrived with my little family of Ornithorhynchi safe at Sydney, and as they survived for some time, an opportunity was afforded me of observing their habits. The little animals appeared often to dream of swimming, for I have frequently seen their fore paws in movement as if in the act. If I placed them on the ground during the day, they ran about, seeking some dark corner for repose; and when put in a dark place, or in a box, they huddled themselves up as soon as they became a little reconciled to the locality, and went to sleep. I found that they would sleep on a table, sofa, or indeed anywhere; but, if permitted, would always resort to that spot in which they had previously been accustomed to repose. Although for days together they would sleep in the bed made up for them, yet on a sudden, from some unaccountable caprice, they would shift their resting-place, and seek repose behind a box, or in some dark retirement, in preference to their former habitation. They usually reposed side by side, looking like a pair of furred balls, and surly little growls issued from them when disturbed; nevertheless, when very sound asleep, they might be handled and examined without evincing any signs of annoyance. One evening both the little pets came out about dusk, went as usual and ate food from the saucer, and then commenced playing, like two puppies, attacking each other with their mandibles, raising their fore paws, and tumbling one over the other. In the struggle one would get thrust down; and at the moment when the spectator would expect it to rise again and renew the combat, it would commence scratching itself, its antagonist looking on and waiting for the sport to be renewed. When running, they were exceedingly animated, their little eyes glistened, and the orifices of their ears contracted and dilated with rapidity; if taken into the hands at this time for examination, they struggled violently to escape, and their loose integuments rendered it difficult to retain

them. Their eyes being placed so high on the head, they do not see objects well in a straight line, and consequently run against everything in the room during their perambulations, spreading confusion among all the light and easily overturnable articles. I have occasionally seen them elevate the head, as if to regard objects above or around them. Sometimes I have been able to enter into play with them by scratching and tickling them with my finger: they seemed to be delighted, opening their mandibles, biting playfully at my finger, and moving about like puppies indulged with similar treatment. Besides combing their fur to clean it when wet, I have seen them preen it with their beak (if the term may be allowed) as a duck would clean its feathers. It is, indeed, interesting to watch them engaged in the operations of the toilet, by which their coats acquire an increased bright and glossy appearance. When I placed them in a pan of deep water, they were eager to get out after being there only a short time; but when the water was shallow, with a turf of grass placed in one corner, they enjoyed it exceedingly. They would sport together, attacking one another with their mandibles, and rolling over in the water in the midst of their gambols; and afterwards, when tired, get on to the turf, where they would lie combing themselves, until the fur was quite smooth and shining. It was most ludicrous to observe these uncouth-looking little creatures, running about, overturning and seizing one another with their mandibles, and then, in the midst of their fun and frolic, coolly inclining to one side and scratching themselves in the gentlest manner imaginable. After the cleaning operation was concluded, they would perambulate the room for a short time, and then seek repose. They seldom remained longer than ten or fifteen minutes in the water at a time. As they were not confined during the night, I sometimes heard them growling; they seemed as if they were fighting or playing, and as if the saucer containing their food had been upset in the scuffle; but, on the following morning, they were quietly rolled up, fast asleep, side by side, in the temporary nest I had formed for them. . . . .

"It was very ludicrous to see the uncouth little creatures open their mandible-like lips and yawn, stretching out the fore paws and extending the webs of the fore feet to their utmost expansion. Although this was natural, yet, not being in the habit of seeing a duck yawn, it had the semblance of being perfectly ridiculous. It often surprised me how they contrived to reach the summit of a bookcase, or any other elevated piece of furniture. This was at last discovered to be effected by the animal supporting its back against the wall, placing its feet against the bookcase, and thus, by means of the strong cutaneous muscles of the back and the claws of the feet, contriving to reach the top very expeditiously. They often performed this mode of climbing, so that I had frequent opportunities of witnessing the manner in which it was done. The food I gave them was bread soaked in water, chopped egg, and meat minced very small. Although at first I presented them with milk, they did not seem to prefer it to water."

In spite of all possible care, none of the specimens of the Ornithorhynchus lived in captivity for a greater length of time than five weeks.

THE MAMMALIA OF NORTH AMERICA.

The total number of species of mammalia now recognized by Prof. Baird, of the Smithsonian Institution, as inhabiting the North American continent, amounts to 220, of which he has himself examined specimens, whilst there are 35 others more or less doubtful. This is a vast increase — no less than 70 species having been added as new to Audubon and Bachman's list, the greater part being the result of the Pacific Railroad surveys. This, too, is exclusive of Cetacea, Pinnipedes and Bats. The first two of these groups can hardly be said to belong to the land fauna of North America, but allowing fifteen species for the Cheiroptera, on the authority of Prof. Leconte, the whole number of positively recognized mammalia belonging to the North American fauna is raised to 235, excluding Pinnipedes and Cetaceans. Taking the several groups in the order in which they stand in Prof. Baird's arrangement, we have first the *Insectivora*, containing shrews and moles, — together 26 species. Of the *Carnivora*, the large number of 46 are recognized as North American, made up of Felidæ and Canidæ, the *Bassaris astuta* of Mexico and Texas, — sole representative of the family *Viverridæ* (civets), — 23 *Mustelidæ*, and 5 species of *Ursidæ*. This is exclusive of several species established by previous writers, but which Prof. Baird has, with much judgment, reduced to the rank of local varieties — such as the *Canis nubilus* of Say, and the *Felis maculata* of Horsfield and Vigors.

The *Marsupialia* in the northern portion of the American continent are represented by two species of the genus *Didelphis*, commonly known as "Opossums."

The Rodents are, again, extremely numerous. In the first place, the Squirrels of different genera, with the Marmots (so called), Prairie-dogs and Beavers, make up no less than 41 members of the family *Sciuridæ*. The *Saccomyidæ*, or Pouched Mice, which, in accordance with Mr. Waterhouse's views, but in opposition to those of Professor Brandt, are grouped together, next follow, and are considered by Professor Baird as "one of the most natural families of Rodentia, although the component genera have been widely separated by different authors. In the external cheek-pouches," he remarks, "there is no other family which exhibits any approach to it. These open outside of the mouth, and are of variable depth, and lined with short hairs to the bottom. When inverted and dried, they look like sacs on each side of the head." Of these peculiar animals, the range of which is confined to Northern America and the Antilles, 21 species are enumerated, as appertinent to the fauna of the United States. Two Porcupines of the North American form *Erethizon* are the only *Hystricidæ* met with in this part of the world; but there are no less than 52 *Muridæ* of varied forms; and 13 Hares and Rabbits, with a single *Lagomys*, give 14 species of the family *Leporidæ*. Altogether, therefore, the order Rodentia in North America, as elsewhere, plays a most important part as regards numbers, embracing 130 species — more than half the whole number of mammals known to occur.

The order *Edentata* is represented within the limits of the United States by a single straggling species of Armadillo, which occurs within

the confines of Texas, and is somewhat doubtfully referred to the *Dasypus novem-cinctus* of Linnæus.

The Pachyderms have also but a single representative, the Collared Peccary, *Dicotyles torquatus*, which, it is remarked, "has a much wider range in North America than is supposed by European systematic writers. It not only occurs through Mexico, but even as far north in the United States as the Red River of Arkansas, in latitude 34°."

The Ruminants, however, muster more strongly, being better adapted for residence in the temperate regions of the North. In the first place, we have the Moose, *Alce Americana.* Then two species of Reindeer are admitted under the titles *Rangifer Caribou* and *R. Grœnlandicus*, though it is allowed that their distinctness is questionable. It is highly desirable that accurate investigations should be made as to the difference of these animals *inter se*, and with the European *R. Tarandus*, which is said to present somewhat corresponding variations. The genus *Cervus* and its subdivisions are represented by no less than six species, which are said to be all truly different, although the distinctions between *Cervus Virginianus* and *C. leucurus*, and *C. macrotus* and *C. Columbianus*, require some further elucidation. North America contains only two Antelopes, the "Prong-horn" (*Antilocapra Americana*), and the so-called "Mountain-goat" (*Haplocerus montanus*), and a single sheep, the well-known Big-horn of the Rocky Mountains, *Ovis montana.* The Musk-ox of the Arctic regions (which, however, does not occur within the limits of the United States), and the Buffalo, *Bison Americanus*, conclude the catalogue of North American Ruminants, making a total of 14 animals of this order. What a contrast in this respect does North America present to Africa, where more than 60 species of Antelopes alone are already known to occur, and the list is daily increasing! For, though we may laugh at Buffon's theory as to the animals of America being merely degraded forms of those of the Old World, there can be no question that the "Great Continent" is far more productive of animal forms of a more highly organized structure, and of a nature more adapted to meet the various wants of mankind.— *Annals and Mag. Nat. Hist.*

FISHES OF NORTH AMERICA AND EUROPE.

At a late meeting of the Boston Soc. Nat. Hist., Prof. Agassiz made the following remarks on a catalogue of the fishes of Jamaica, presented to the Society by the Hon. Richard Hill:—

He regarded it as interesting for purposes of comparison with the species of North America and Europe. It is well known that the fishes of the two sides of the Atlantic are specifically distinct, except a few northern ones, which are identical, not from crossing from one continent to another, but from migrating southward on both shores from the same Arctic centre. As maps are usually drawn, the average temperature of the water for the year is taken as regulating the geographical distribution of fishes; but, as Prof. Dana has shown in his report on the Crustacea of the U. S. Exploring Expedition, the average of the greatest cold has a more important influence in this

distribution. From the Arctic, Gulf-stream, and African currents, the modification of the zones of temperature in the Atlantic is very striking. For instance, the temperate zone on the American side extends only from Cape Hatteras to Cape Cod, about ten degrees of latitude, while on the European it extends from the coast of Sweden to the Cape de Verd Islands, nearly five times as many degrees. On the contrary, the tropical zone, which extends in America from Cape Hatteras to 25° S. latitude, or sixty degrees, extends only about twenty degrees on the African Guinea coast. The line of temperature established by the average of the thirty coldest days in the year gives the clue to the distribution of the marine fauna; in America this is essentially tropical, and in Europe essentially temperate.

Of the families mentioned in this list, the *Cottoids* are essentially North American, and there are five in Jamaica; the *Sciœnoids* are tropical, Europe having but a few; the *Sparoids* are essentially Mediterranean, where fifteen genera exist, and there are four in Jamaica; the *Squammipennœ* are tropical, and numerous in Jamaica; the *Scomberoids* are cosmopolitan, and numerous everywhere; the *Mullets* are tropical, and there are several in Jamaica; the *Labroids*, very rare here, are numerous in the tropics; the *Cyprinoids*, though quite cosmopolitan, have never been found in South America, and there are none in Jamaica; one *Centropomus* is found in fresh water in Jamaica, which is unusual; the *Siluroids* are few, and those of America few in comparison with those of Asia; while a kindred family, the *Goniodonts*, are peculiar to this country; the *Pleuronectidœ* belong to the temperate zone, yet there are few here.

J. M. Barnard, Esq., stated a fact in confirmation of the tropical character of the American marine fauna: he had lately received a keg of echinoderms from Zanzibar, in 5° S. latitude, which were almost identical with those from East Florida.

CURIOUS FACTS IN RELATION TO THE COD.

At a recent meeting of the Boston Nat. Hist. Soc., Capt. Atwood stated that fish are often swallowed by the cod, pass from their stomach into the abdominal cavity, and are there found "mummified" and adherent to the inner walls; he presented a specimen, apparently of the eel family, thus preserved and hardened, which he had taken from the abdominal cavity of a pollock. Cod are often so wounded by the hooks that the intestines hang out in the water, and yet such fish are seen swimming about with the rest without apparent suffering, and he had no doubt that they bite at the hooks in a few days. He presented two large cod hooks, with portions of the line attached, which he had taken from the livers of apparently healthy cod. The greater part of the hooks was buried in the organ, and must have remained there, he thought, at least twelve months; they must have been swallowed, broken off, and have worked their way through the stomach into the liver.

RATE OF INCREASE OF FRESH-WATER SHELLS.

At a recent meeting of the Boston Society of Natural History,

Prof. Agassiz made the following observations on the rate of increase and other characters of fresh-water shells, Unios.

To determine their rate of growth, he had collected large numbers during every month in the year; he always found many series of shells of different sizes, all of a size in each series, the whole suite of specimens representing all the intermediate sizes, and, as he believed, the rate of growth and annual increase. Though different species breed at different seasons, none breed more than once a year, as is proved by examination of the gills in which the eggs are deposited. The small shells, less than an inch long, have generally been regarded as of only a year's growth, and as immature; he found them filled with eggs at this small size, and considered them as from seven to nine years old, instead of one, and as mature.

The *Naiades* have until recently been studied chiefly by amateurs, and not by naturalists and from the shells alone. Rafinesque made a good beginning with the Kentucky species, separating *Unio alatus* as the type of his genus *Metaptera*. Mr. Lea separated the same as *Symphynota*, uniting under it, however, species entirely dissimilar. In *Metaptera* (Raf.), the inner gill is united at the upper margin with the side of the foot, there being no communication between the foot and gill cavities, as occurs in *U. complanatus*, so that the eggs must pass back of the gill, and by a very circuitous course; the hind part of the gill only is filled with eggs, in a kind of pouch, and the edge of the mantle opposite is ciliated, evidently for the physiological purpose of securing an ample supply of water, — in itself a good generic character. The species are the *M. alata*, the same from the Alabama and the rivers flowing into the Mississippi, though described under various specific names in different localities, as *U. Alabamensis* and *Poulsoni; M. Ohioensis* or *U. lævissimus* of Lea, from rivers emptying into the Ohio and upper Mississippi and Missouri; and *M. gracilis*, also from the Northern States. In their early coming to maturity this family is similar to fishes. The pickerel of the Swiss lakes, which attains a length of three or four feet, and a weight of twenty to thirty pounds, spawns under a foot in length and a pound in weight. Alligators, also, lay eggs when quite small.

Dr. Gould remarked that this method of examining shells must be very fruitful in results. At first, the animals of shells were not studied at all. Mr. Lea finds now four hundred species of fresh-water shells in America, whereas, not many years ago, only about twenty were known all over the world. He stated that there was a great confounding of species, and even of genera, among Unios. He inquired, if the striæ correspond to a year's increase, if a species cannot breed at the age of one year, and what proof there was that these small shells were seven to nine years old? He had found shells which certainly grew to this size in a single year in favorable localities, and specimens attain the dimensions which Prof. Agassiz attributed to a life of thirty or forty years, in three or four years.

Prof. Agassiz replied that the finding of definite sizes at different months, without any intermediate degrees in each series, had satisfied him that the layers of increase were annual. Some species grow rapidly for the first few years, and then slowly, and others in a uniform manner; they also grow more rapidly in some waters than in

others, so that the dimensions observed in one river are no guide for those in another. All of the large shells found in waters which had flowed for only three or four years might not have grown from eggs deposited there; mature shells may have crept into such waters. The Unios lay thousands of eggs, in some species very mature, in others less so.

In answer to an inquiry from Dr. Jackson, whether, from the ascertained growth of shells in this manner, it would be possible to deduce the approximative period during which geological strata, composed principally of shells, had been deposited, Prof. Agassiz replied that he was satisfied that nothing could be obtained from such data; the elements of the problem were not in them.

DISTORTED GROWTHS IN SHELLS.

At the meeting of the British Association, 1860, Mr. H. H. Higgins stated that the late Mr. Gaskoin, of England, had in his museum a series of specimens, collected for the purpose of illustrating the pathology of the Mollusca. This series was in course of formation in the year 1835, from which period, to the time of his decease, Mr. Gaskoin devoted considerable attention to the selection, from various sources, of specimens of shells in any wise remarkable for distorted growth, or for the repair of injuries received during the life of the animal. In the course of more than twenty years' collecting, Mr. Gaskoin had enriched his pathological cabinet, not only with a great variety of mended fractures and distorted growths, but with many duplicates, sometimes of cases apparently altogether exceptional, and likely to be unique. A select series of specimens was then exhibited to the Section, and remarks were made upon them, which can scarcely be presented intelligibly apart from the specimens themselves. — *London Athenæum.*

HABITS OF THE BEAVER.

The following letter, from Mr. A. H. Smith, of Solano Co., California, "On the Habits of the Beaver," was recently read before the Academy of Sciences, Philadelphia: —

"This winter I have had an opportunity of observing somewhat the habits of the Beaver. You know that this cunning little animal is famed for his industry and bold engineering. About the middle of our land there is a large slough seventy feet wide and very deep, running back into the country. In the progress of our work, it became necessary to stop it off and lay a large sluice to drain it, which was done in a complete manner.

"At the head of the slough, two miles away, the beavers had their settlement. When the water fell away from their houses, and would not return, as usual, they seemed to have sent a delegation down to see what was the matter. For several successive mornings we found a dam built across the race leading to the sluice, quite skilfully made with sticks and *tulés*, and cemented with mud. One of the men agreed to watch for them, with the hope of securing their skins, which are of some value. The night was bright moonlight. Four

beavers came down, examining either bank carefully. One of the party always remained in the water, and seemed to be the commander, and would turn from the one to the other to see that each did his duty. At length they reached the dam, still observing the same caution. The three examiners came out and went all over it and into the sluice, chattering the while to their companion in the water. Finally, they seemed satisfied that it was past their skill, and went off. Since then we have had no further trouble with them."

THE WINTER SLEEP OF MARMOTS.

The winter sleep of marmots has been investigated by M. G. Valentine, particularly with respect to the movements of the heart and respiration, and the intravascular pressure during sleep. The insertion of a needle into the apex of the ventricles was borne by a marmot twenty-four hours without waking; the sleep even appeared to be more profound, and the number of pulsations increased. The duration of each pulsation is longer when the animal is asleep than when it is awake.

The shaking of the table on which it was placed, and the moistening the sole of its foot with sulphuric acid, sensibly increased the number of pulsations. With respect to the intravascular pressure, M. Valentine states that the abstraction of a considerable quantity of blood by secondary hemorrhage caused the marmot, after six hours' sleep, to wake up to vigorous action.

SHEDDING OF THE ANTLERS OF THE RED DEER.

At a recent meeting of the Boston Society of Natural History, Professor Wyman gave an account of some observations on the shedding of the antlers of the American red deer.

After the rutting season is past, and, in consequence of the stoppage of the circulation through them, they have become dry and dead, the antlers are separated from the living frontal bone by a process of absorption carried on by the Haversian canals. These, acting on one plane through the whole thickness of the bone just below the "bur," remove the solid materials around them, so that each canal becomes dilated on that plane until its cavity unites with that of an adjoining one. When this process has extended entirely across the base, the antler drops. The fall of the antler was shown to have a close resemblance to the process by which, in necrosis, the dead is separated from the living bone.

He also was disposed to regard the antler as a dermal bone, rather than a portion of the endo-skeleton; 1st, because it is developed in the integuments by a special centre of ossification, and only becomes attached to the frontal bone after ossification has somewhat advanced; 2d, because the permanent antlers of the giraffe do not become united with the cranium, except by suture, until late in life, and are developed over the parietal as well as the frontal bones, without being divided on the line of the sutures of these two bones, which they would be were they merely epiphyses of them.

manner in which their instinct enables them to overcome unexpected difficulties when they occur. A mole, as it is said, was suspended to the upper end of a stick fixed firmly in the ground, and the scent of the carcass soon attracted the 'Sextons,' who appeared at first much disconcerted by the situation of the coveted supply of provender for their future progeny. After a kind of consultation, however, which appears to have been very much to the point, they proceeded to undermine the stick, which, yielding to a few hours' unceasing labor, at last fell, and the prize was secured and duly interred after the usual fashion."

INTERESTING ILLUSTRATION OF ANIMAL INSTINCT.

Dr. Asa Fitch, the well-known American entomologist, has recently published the following curious and well-attested story, illustrative of the instinctive skill and sagacity of the common house-spider. The incident occurred in a store in the village of Havana, Chemung County, New York, and is authenticated by a great number of witnesses.

An ordinary-looking spider of a dark color, its body not larger than that of a common house fly, had taken up its residence, it appears, on the under side of a shelf beneath the counter of the store in question. What may we suppose was the surprise and consternation of this little animal on discovering a snake, about a foot long, selecting for its abode the floor underneath, only two or three spans distant from its nest? It was a common silk snake, which, perhaps, had been brought into the store unseen in a quantity of sawdust with which the floor had been recently "carpeted." The spider was well aware, no doubt, that it would inevitably fall a prey to the snake monster the first time it should incautiously venture within its reach. We should expect that, to avoid such a doom, it would forsake its present abode, and seek a more secure retreat elsewhere. But it is not improbable that a brood of its eggs or young was secreted near the spot, which the parent foresaw would fall a prey to the enemy if they were abandoned by their natural guardian and protector. We can conceive of no other motive which should have induced the spider so pertinaciously to remain and defend that particular spot, at the imminent risk of her own life, when she could so easily have fled and established herself in some secure corner elsewhere. But how, we may well ask, was it possible for such a weak, tender little creature to combat such a powerful mail-clad giant? Her ordinary resort, that of fettering and binding her victim, by throwing her threads of cobwebs around it, it is plain would be of no more avail here than the cords upon the limbs of the unshorn Samson. . . . . .

By what artifice the spider was able in the first of its attack to accomplish what it did, we can only conjecture, as its work was not discovered until the most difficult and daring part of its feat had been performed. When first seen, it had placed a loop around the neck of the serpent, from the top of which a single thread was carried upward and attached to the under side of the shelf, whereby the head of the serpent was drawn up about two inches from the floor. The snake was moving around and around incessantly, in a circle as large

as its tether would allow, wholly unable to get its head down to the floor, or to withdraw it from the noose; while the heroic little spider, exulting no doubt in the success of its exploit, which was now sure beyond a peradventure, was ever and anon passing down to the loop and up to the shelf, adding thereby an additional strand to the thread, each of which new strands, being tightly drawn, elevated the head of the snake gradually more and more.

But the most curious and skilful part of the performance is yet to be told. When it was in the act of running down the thread to the loop, the reader will perceive it was possible for the snake, by turning his head vertically upward, to snap at and seize the spider in his mouth. This had, no doubt, been repeatedly attempted in the earlier part of the conflict; but, instead of catching the spider, his snakeship had only caught himself in an additional trap. The spider, probably by watching each opportunity when the mouth of the snake had been turned towards her, adroitly, with her hind legs, as when throwing a thread around a fly, had thrown one thread after another over the mouth of the snake, so that he was now perfectly muzzled, by a series of threads placed over it vertically, and these were held from being pushed asunder by another series of threads placed horizontally, as my informant states he particularly observed. No muzzle or wicker-work for the mouth of an animal could be woven with more artistic regularity and perfection; and the snake occasionally making a desperate attempt to open his mouth, would merely put these threads upon a stretch.

The snake continued his gyrations, his gait becoming more slow, however, from weakness and fatigue; and the spider continued to move down and up the cord, gradually shortening it, until at last, when drawn up so far that only two or three inches of the end of his tail touched the floor, the snake expired, about six days after he was first discovered.

A more heroic feat than that which this little spider performed is probably nowhere upon record.

At a recent meeting of the Academy of Natural Sciences, Philadelphia, Mr. Lesley read the following extract from a letter written by Mr. E. A. Spring, of Eagleswood, N. J.: —

"I was over on the South Amboy shore with a friend, walking in a swampy wood, where a dyke was made, some three feet wide, when we discovered in the middle of this ditch a large black spider, making very queer motions for a spider, and on examination it proved that he had CAUGHT A FISH.

"He was biting the fish, just on the forward side of the dorsal fin, with a deadly gripe, and the poor fish was swimming round and round slowly, or twisting its body as if in pain. The head of its black enemy was sometimes almost pulled under water, but never entirely, for the fish did not seem to have enough strength, but moved its fins as if exhausted, and often rested. At last it swam under a floating leaf at the shore, and appeared to be trying, by going under that, to scrape off the spider, but without effect. They then got close to the bank, when suddenly the long black legs of the spider came up out of the water, where they had possibly been embracing the fish (I have seen spiders seize flies with all their legs at once), reached out be-

hind, and fastened upon the irregularities of the side of the ditch. The spider then commenced tugging to get his prize up the bank. My friend stayed to watch them, while I went to the nearest house for a wide-mouthed bottle. During the six or eight minutes that I was away, the spider had drawn the fish entirely out of the water, when they had both fallen in again, the bank being nearly perpendicular. There had been a great struggle; and now, on my return, the fish was already hoisted head first more than half his length out on the land. The fish was very much exhausted, hardly making any movement, and the spider had evidently gained the victory, and was slowly and steadily tugging him up. He had not once quitted his hold during the quarter to half an hour that we had watched them. He held, with his head toward the fish's tail, and pulled him up at an angle of forty-five degrees by stepping backwards. How long they had been there, or how far they had come, we cannot tell. We saw no web anywhere about.

"The time would not permit a longer stay, so we reluctantly bottled the pair. I thought I had missed dipping up the spider, and looked along the bank, but on turning to the bottle he was there. The fish was swimming weakly at the bottom of the water that I had dipped in, and the spider standing sentinel over him on the surface, turning when he turned, and watching every motion. We stopped the mouth of the bottle so that the spider could not escape, and went above on the hill. Returning in about three hours, we found, to our disappointment, the spider dead at the bottom, but the fish was alive. He lived for twenty-four hours. The spider was three-fourths of an inch long, and weighed fourteen grains; the fish was three and one-fourth inches long, and weighed sixty-six grains."

MUSKY SECRETIONS OF ANIMALS. BY PROF. GIRARD.

The substances known under the general name of *musk*, on account of their special odor, are met with in various classes of animals having an aerial respiration. Their production depends specially on the function of generation, and the glands furnishing them are generally placed near the genital apparatus. In the larger number of cases, the males present this musky secretion in a large amount; it remains rudimentary with the females, which in the animal kingdom may be considered as offering an arrest of organic development as compared with males, although rigorously following the same type. The Asiatic Roussettes (*Pteropus*) have their urine strongly musky, and the odor impregnates their flesh, so that the Malays hunt after them as delicacies, as Peron and other travellers testify. Two allied species of carnivora, civets and zibeths, furnish most of the musk used in pharmacy and perfumery. The males, especially at the period of rutting, furnish more musk than the females, in the pouches near the genital organs. This position indeed is invariably occupied by the organs secreting musk in the mammalia. The *genet* of the next genus presents the same secretion, rudimentary in the female and much more abundant than is generally supposed in the male at the time of rutting. The dung of the wild polecat is musky, while its odor is infectious when the animal is a captive. Among the insectiv-

orous carnivora the musky secretion may be observed in a natural group of the largest species of shrews (*musareignes*) — these are known as the *musareignes musquées* of some authors, and are the *Sorex, Myosurus giganteus*, etc. The two singular species of the tribe of Desmans (*Mygale*) also exhibit very well developed musky secretions. Beyond doubt, there are variable mixtures in these secretions, and possibly several varieties of musk, for the perfume obtained from the anal pouches of the *moschus moschiferus* is of a pure and more lasting nature than that from the civets; this is the musk which is so rare and much sought after in Indo-China, whose odor persists for years without any sensible diminution of weight.

Among birds, the musky odor of the duck of Barbary (*Anas moschatus*) is well known, and that given off by vultures at the time of pairing, laying and hatching — an odor which also impregnates their eggs. The three genera of crocodiles also furnish a musky secretion, due to glands situated near the jaw. This odor is communicated to the whole body, and exhaled strongly from their eggs when boiled, as has been observed at Hayti, by Dr. A. Ricord, in the flesh and eggs of *Crocodilus acutus*.

We should not be surprised at meeting in insects that are so approximate to the vertebrata, if not their superiors, in the development of the functions of animal life, musky secretions analogous to those which we have just noticed, and which seem also to characterize natural groups. Facts of this kind, being much less known concerning insects than concerning vertebrata, seem to merit special attention.

Writers of the natural history of the Lepidoptera indicate the *Sphinx convolvuli* as exhaling a strong musky odor. It is very perceptible in the males, and I am induced to believe is peculiar to them, for several females that I had an opportunity of examining while alive were absolutely free from it. I believe that once I detected a slight musky odor in a female of this class, which I had caught, but it was explainable by the fact that copulation had just been effected. I have observed the same musky odor, with less prominence, however, in an allied species, — *Sphinx ligustri*, — a fact not noticed before by writers. This odor was well developed in the vessel in which the male insect was confined, and seemed to proceed from all parts of the body, especially the abdominal segments. It would be interesting to examine the male of the *Sphinx pinastri*, the third species of this genus, with reference to this point. It would be a character to add to those of the genus, and a novel example in support of the view that the secretion of the same odorous substances is met with in species united by one true zoological parent.

Berce says that the musky odor also belongs to a different lepidoptera — *Charaxes jasius*. This is the beautiful day butterfly found all along the Mediterranean coast, which the Turks call the *pacha of two tails*. The odor is especially developed when the insect struggles to escape death.

Chevrolat cites, among coleoptera, as affording a strong musky odor, *Velleius dilatatus* — a rare staphylinide, a parasite of the nests of different species of wasp. A number of species of ants give off a decided musky odor, especially when their ant-hills are destroyed; and this secretion accompanies a product of a different nature —

formic acid, as can be seen by the red tracks the ants will then make in running over litmus paper. The musky secretions of these insects of different orders could not proceed from the plants which serve to support the adults or larva, whilst the odor of fennel exhaled by *Papilio machaon*, as Martin informs me he has often determined, is explained by the vesicles of essential oil of that odor which are scattered over the umbelliferæ, on which the caterpillar lives. Some insects exhale agreeable odors; thus the *staphylinus odens* gives off the odor of apples (*pomme de reinette*), or of nitrous ether; the coleoptera known by the name of *Aromia moschata* does not exhale the odor which its name indicates, but that of the essence of Levant roses. It furnishes a sweet and persistent perfume, and the secretion is analogous to that of the willow, on which it feeds and lives. Both sexes are odoriferous.

The odor of the rose, sometimes not very pure and mixed with another odorous substance, is found in the *Cicindela campestris* and *hybrada;* the odor is analogous to that of the products obtained by treating essence of turpentine with nitric and sulphuric acids. The males particularly present the secretion. Nothing is less known than the nature of the essence of roses, a mixture of several substances, which is obtained, not, as the treatises on chemistry and pharmacy say, by distilling the flowers of the rose, but, according to Boisduval, by the distillation of the root of a *Convolvulus*. It is well known, and examples are furnished by this continually in organic chemistry, that the same carbides of hydrogen can be met with in very different species, whether animal or vegetable. Without attaching too great importance to the connection between the two kingdoms of organic nature, we may remark that the plant commonly known as *musk* (*mimulus moschatus*), on account of the odor of its yellow flowers, only presents this odorous secretion in its organs of reproduction.

Laboulbene regards the secretions of odoriferous materials in insects as being naturally of two groups. Sometimes they proceed from liquids which exude from all parts of the body, as in cochineals; or they are dependencies of the buccal apparatus, as in the sylphs and different scarabæi that disgorge an infectious liquid — here they belong to both sexes, and may exist in the larvæ; sometimes, on the other hand, and such are the musky secretions of the sphinx, the odoriferous secretions only exist in the adults, are special to the males, only appearing rudimentary in the females — thus, in the cicindelidæ, they are due to connected glands disposed in a species of elegant arborization around the testicular apparatus, in a manner analogous to the arrangement of the odoriferous glands of the musky mammiferæ, where the glands are largest in the male and are situated near the genital organs.

The production of musky matter seems to belong, in tropical countries, to the warm, humid, vegetable soils. Several travellers relate that they were struck with the strong odor of musk exhaled from the earth, especially in the morning, in the forests of the isles of Sunda, and in Central America. Without speaking of Jacquinot, de Quoy, and Gaimard, etc., Humboldt may be cited with reference to the musky odor which is produced in the arid plain of Cumana, after heavy inundations. He attributes it to the débris of jaguars, tiger-

cats, seahogs, vultures, crocodiles, vipers, and rattlesnakes buried in the soil, and that the gaseous emanations which are the vehicles of this aroma are only disengaged when the earth containing these bodies is saturated with water. This explanation seems problematical, and analogous to the ancient hypothesis which attributed the phosphorescence of the sea to cadaveric débris, while it is produced by a multitude of living beings of different species. Possibly these musky emanations of tropical soils are due to the development of inferior organized beings, probably cryptogamic in character. — *Cosmos.*

THE GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

Mr. Darwin, in his recent work on the "*Origin of Species,*" energetically denies the doctrine of the origination of organic forms from "specific centres." Wherever the same species are found in distant districts the fact may, he thinks, be most probably accounted for by migration. On this view the supreme importance to geographical distribution of the presence of impassable barriers is readily understood; the seas on either side of a continent, and the continents on either side of a deep and wide ocean, being respectively inhabited by very different races. In taking this view, however, he does not make so much use as some naturalists — the late Edward Forbes, for instance — have done of the influence of geological changes in uniting districts which are now separated, but is inclined to rely more exclusively upon the ordinary and still existing means of dispersal. These are, he thinks, both more numerous and more effective than are generally supposed. He shows that the seeds of many plants can bear long immersion in sea-water, or imprisonment in the crops of birds, without losing their vitality; and they may also be transported largely from place to place in the mud adhering to the feet of living birds. Of the cases which are generally cited as militating against the doctrine of a single centre of creation, the two strongest are perhaps the presence on distant mountains of the same species, and the wide distribution of fresh-water forms. The former fact Mr. Darwin accounts for by the uniform southward migration of northern forms during the cold period which preceded and accompanied the glacial epoch; some of which forms, when the temperature of the region again rose, instead of returning northward, retreated into the mountains of the district in which they chanced to be. The wide distribution of fresh-water species he attributes to slight geological changes of level, which have at more or less remote periods enabled rivers, which now are without inter-communication, to flow into each other; and also, in no small degree, to the agency of living birds already alluded to. The following passage, bearing on this latter point, is so interesting, that we give it in Mr. Darwin's own words: —

"I have before mentioned that earth occasionally, though rarely, adheres in some quantity to the feet and beaks of birds. Wading birds, which frequent the muddy edges of ponds, if suddenly flushed, would be the most likely to have muddy feet. Birds of this order I can show are the greatest wanderers, and are occasionally found on the most remote and barren islands in the open ocean; they would not be likely to alight on the surface of the sea, so that the dirt

would not be washed off their feet. When making land they would be sure to fly to their natural fresh-water haunts. I do not believe that botanists are aware how charged the mud of ponds is with seeds. I have tried several little experiments, but will here give only the most striking case: I took in February three table-spoonfuls of mud from three different points, beneath water, on the edge of a little pond; this mud, when dried, weighed only six and three-quarter ounces; I kept it covered up in my study for six months, pulling up and counting each plant as it grew. The plants were of many kinds, and were altogether five hundred and thirty-seven in number; and yet the viscid mud was all contained in a breakfast-cup. Considering these facts, I think it would be an inexplicable circumstance if water birds did not transport the seeds of fresh-water plants to vast distances, and if consequently the range of these plants was not very great. The same agency may have come into play with the eggs of some of the smaller fresh-water animals."

In connection with these statements of Mr. Darwin, the following, from the Proceedings of the Philadelphia Academy, will be read with interest: —

Mr. Lea mentioned that he had recently received a letter from Dr. Showalter, of Uniontown, Alabama, in which he mentions that specimens of *Physa (gyrina)* Say, which he sent on, were obtained in an open neglected cistern, and in a trough of water supplied by an artesian well ten miles from the town. Dr. Showalter expressed his surprise that these *Physæ* should find their homes so soon at these artesian wells. There are no streams or pools near to these wells, but in a few years after they are bored, and water supplied, these shells may with certainty be found. Mr. Lea went on to mention that he had, nearly thirty years ago, found an undescribed species of *Lymnæa*, accompanied by *Physa heterostropha* Say, in a small artificial pond on the high grounds near to the Falls of Schuylkill, about four miles north of Market Street, now within the limits of this city. He published an account of it in April, 1834, in the *Transactions of the American Philosophical Society*, under the name of *acuta*. The pond was small, and dug out, for one and one-half to two feet deep, simply for the supply of rain-water for cattle. Afterwards it dried up, and the shells were no longer to be obtained there. He never found this *Lymnæa* in any other habitat; but many years subsequently, Dr. Ingalls, of Greenwich, N. Y., near to Lake Champlain, sent him several specimens of what he regarded as a new *Lymnæa*, but which was at once recognized as the *acuta*, heretofore found only in the one habitat near the Falls of Schuylkill. In the minds of some zoölogists a difficulty exists as to the existence of species in such constricted, isolated points as mentioned above, but that difficulty, in Mr. Lea's mind, was done away with under the belief that very young mollusks may be transported on the feet of birds from distant points, or on those of cattle going to drink from one place to another.

CEREBRAL SYSTEM OF CLASSIFICATION OF THE MAMMALIA.

In a lecture recently given before the Royal Institution, London, Professor Owen stated that the lowest forms of mammals possess

brains of a character which he expresses by the name he proposes for the group, *Lyencephala*, or "loose brains." The mammalia with these brains are the *Monotremata* (echidna and ornithoryncus) and the *Marsupialia.* In both these groups the cerebral hemispheres are in "a loose or disconnected state," as compared with those of higher animals. The marsupials are mostly nocturnal, or appear abroad during the day only in dark, rainy weather; and the Professor considers their low position associated with the prevalent habit of limiting the faculties of active life to the obscurity of night. The second ascending type of brain is found among the *Rodentia*, *Insectivora*, *Cheiroptera* and *Bruta*, or *Edentata;* and these Dr. Owen proposes to call *Lissencephala*, or "smooth brains;" a name referring to the smooth, unconvoluted exterior of that organ. The Professor pointed out the numerous relations presented by this group to the oviparous vertebrata, and remarked that the most ancient mammals whose fossil remains were found in secondary strata were either Ly- or Lissencephalous, and belonged either to the *Marsupialia* or the *Insectivora.* The third type of brain was found in monkeys, lemurs, etc., and named *Gyrencephala*, or "winding brains;" so called from their convolutions. This division was subdivided into the *Mutilata*, so called because their hinder limbs seemed, as it were, to have been amputated, comprehending *Cetacea* and *Sirenia;* the *Ungulata*, divided into *Perissodactyla* and *Artiodactyla*, according to the odd or even number of their toes, — the single hoof of the horse, the triple hoof of the tapir, exemplify the first; the double hoof of the camel, the quadruple hoof of the hippopotamus, the second, — and the *Unguiculata.* The Professor pointed out the superior utility to man of the members of this division now in existence, compared with the service which could have been rendered if their predecessors in geological time had survived down to the human epoch. The present ruminants, for example, more thoroughly digest grass, and form out of it a more nutritive meat, and the present monodactyled horse was a better and swifter beast of draught than his tridactyle predecessor, the miocene *Hipporion*, could have been. Passing from Quadrumana, the fourth and highest type of brain rises at once to that "marvellous structure which is peculiar to our own species;" and the sole representative of this class is Man, described as *Archencephala*, or 'overruling brain."

PHYSIOLOGY OF VISION.

At a recent discussion before the Boston Society of Natural History, Professor Rogers remarked that he thought that the physiology of vision was as yet but imperfectly understood; vision by corresponding points of the two retinæ, for instance, cannot be maintained, though it is found in all treatises on physiology, and in most on optics.

Dr. Gould referred to the fact that though in strabismus there is distinct vision with the normal eye, the other being unused, squint-eyed-persons cannot get the stereoscopic solid image, but only see a flat picture.

Professor Rogers remarked that there is such a thing as being right-eyed and left-eyed, as well as right-handed and left-handed; indeed,

many persons use but one eye for taking their direction in vision, and that is generally the right; it is sometimes the left, but in normal instances an object is seen in the median plane between the two eyes. Many persons have the idea that stereoscopic vision is only squinting, but this is very far from being the case; in squinting, the eyes converge to a point nearer than that of distinct vision; in stereoscopic vision the eyes are not so directed, and the sense of fatigue and discomfort is owing to the forcible dissociation of two naturally associated actions. In common vision there are two adjustments, one consisting in directing the optic axes to the object, the other in adjusting them to suit the distance of the object from the eyes, drawing them, so to speak, out or in like the joints of a telescope; habit enables us to effect these two adjustments instantaneously and at the same time. In looking through a stereoscope, while the object is very near, we are forced to extend our optic tubes to see an object apparently at a great distance, and thus the union of the associated motions is violently broken up, causing a sense of fatigue.

PHYSIOLOGY OF WIDOWHOOD.

A correspondent of the London *Medical Times and Gazette* thus writes in relation to the above subject: —

For some time past my attention has been attracted to a very curious form of hereditary transmission of physical peculiarities, which I think worth while to lay before the profession, that more extensive and more accurate investigation than I can accord it may, if not exactly, at least proximately, determine its value as an influence in the production of disease.

Lord Morton bred a hybrid from a chestnut mare and male quagga — the hybrid was quagga-like, and even the foals subsequently produced from the mare by a black Arabian sire were "much more plain barred across the legs than is even the pure quagga." Now, here is an instance of the positive transmission by the female of one species of the physical peculiarities of the male of another species, with whom she had bred, to her offspring by a subsequent union with a pure male of her own species. This in itself is not a little remarkable, and worthy of investigation, by those who have opportunity, amongst mule-breeders and others; but, further, I have made many inquiries amongst those interested in the pure breeds of all kinds of cattle, sheep, dogs, poultry, pigeons, etc., and they universally declare that if a high-bred female once breeds with an inferior male, even of her own race, she will never produce pure offspring, though she always, subsequently, breed with males of the highest caste. Thus, if a thorough-bred mare have a colt whose sire is a half-bred horse, though she subsequently breed with only thorough-bred horses, her foals will never prove thorough-bred. An instance was lately mentioned to me much in point, where a very pure-bred setter bitch produced her first litter after a cur dog, and, though subsequently put to some of the best setter dogs in the kingdom, her puppies were never pure or worth keeping. We know that the greyhound breeders cross with a bull-dog to give their greyhounds courage and tenacity of purpose, and that it does this for many generations; but that it is effected by

always breeding from the progeny with greyhounds, subsequently to the first bull-dog cross. It would be curious to inquire whether the greyhound bitch subsequently breeding with pure greyhound, her progeny would show a similar transmission of the courage of the bull-dog, as we have seen it take place in the markings of the quagga, and the worthless peculiarities of the cur.

Now, we only too well know that many diseases are capable of hereditary transmission, some more, some less; and I cannot but think the facts I have alluded to lend some color to the thought, that even as physical peculiarities, so may diseases, be transmitted by the female, though herself and the actual father of her second progeny, as well as all their ancestors, may be free from any taint. In other words, it would seem far from improbable that if a woman married, and had a child by a man who died the subject of any well-marked hereditary disease, and she subsequently married and had children by her second husband, her first husband's disease would have a tendency to show itself in her second family, even though neither she nor her second husband, or their ancestors, were subject to the malady. I presume that one point would be necessary to this, namely, that at the time of impregnation by the first husband, he was then either absolutely suffering from or very strongly predisposed to the disease transmitted. The investigation of this very curious and interesting question would incidentally throw much more light on how far constitutional peculiarities and diseases, such as gout, tubercle, insanity, etc., may be communicated by seminal transmission to the female, and be of considerable importance in determining many medical and social questions, as the first husbands of widows, who re-marry and bear children, have frequently died of the severer forms of disease well known to be capable of hereditary transmission.

HALLUCINATIONS.

One of the most curious of recent contributions to science is a treatise on Hallucinations and kindred Mental Phenomena, by M. Briene du Boismond, a French medical writer of eminence. The object of the author is to establish the theory that in all cases of hallucination the physician, quoting that term in its strictest sense, might trace a physical cause, detect some flaw or change in the bodily system, were he enabled, by the progress of science, to pursue his investigations far enough. Ten classes of hallucinations are tabulated. The first contains such as co-exist with a sound understanding, whether or not corrected by the mind. These affect the sight, hearing, smelling, tasting, and touching faculties. In the second we have simple forms of insanity, uncomplicated by mania or dementia. Next stand those which *are* thus complicated. The results of excess, whether in drinking, the use of narcotics, and the introduction of poison into the system, occupy a category apart. Then come the ghastly variety of nervous diseases, from catalepsy to hydrophobia, followed by nightmare and dreams, ecstasy, hallucinations connected with febrile maladies, and "epidemic hallucinations." The definition given by M. Du Boismond of a hallucination is as follows:—

"We define a hallucination as the perception of the sensible signs

of an idea, and an illusion as the false appreciation of real sensations."

And he further claims that, however real a phantom may be to the vision, mental or physical, and however impossible it may be at present, anatomically, to fix the source and centre of the disease by the examination of victims after death, there is something in the human body which, however minute, would explain the malady of the mind, if only the microscope of science were subtle enough to discover it.

NATURE OF THE DEEP-SEA BED, AND THE PRESENCE OF ANIMAL LIFE AT VAST DEPTHS IN THE OCEAN.

The following paper, contributed to the London *Engineer Journal* by Dr. G. C. Wallich, the naturalist who accompanied the recent expedition sent out by the British government to make soundings in the extreme North Atlantic (with a view of determining the practicability of laying a submarine telegraph cable between England and Ireland and the American continent), will be found to contain matters of great and novel interest: —

Although the depth of the sea over widely-extended areas has been approximately ascertained, hardly any attempts were made to investigate the character and composition of the ocean-bed until the period when submarine telegraphs were first undertaken. In the absence of any special object, such attempts would have been far too costly and difficult to be practicable. It has been ascertained, however, that the floor of the ocean is but the reflex, as it were, of the dry land; that it is in no place unfathomable; that along its deeper portions certain muddy deposits are to be met with, in many cases made up, more or less entirely, of minute calcareous shells belonging to one of the most simple order of beings with which we are acquainted; and that together with these are also to be found, but in comparatively speaking small quantity, the minute, flinty skeletons of other organisms derived both from the animal and vegetable kingdoms. But no conclusive evidence has been produced to show whether any, or all of these organisms normally lived and perished at the profound depths from whence they were obtained by the sounding lead, or whether, having inhabited distant and perhaps shallower seas, their dead remains alone, after being transported by currents or other agencies, had gradually subsided into the deep hollows of the ocean. Taking into consideration the very important part played by these organisms in the structure of the earth's crust, that vast strata have in ages gone by been built up of them, and that similar strata are at the present time being deposited along the beds of existing seas, the investigation of these questions becomes of the highest consequence. The distribution of animal life in the upper waters of the sea is determined by climate, by the composition of its waters, the nature of its bed, and its depth in any given locality; the last of these items necessarily involving the relative degrees of temperature, light, aeration, and pressure, as compared with those to be met with near the surface. Of these conditions, climate exercises a very powerful influence; for it is found, as we advance from the equator towards the poles, that a grad-

ual diminution takes place, not only in the number of types met with, but of the varieties ranged under those types. It has been maintained that, in order to compensate for the diminution in the number of generic forms, the number of individuals of each species is much augmented. Although this law holds good as regards the higher orders, it can hardly be said to do so in the case of the lower; for the vast assemblages of these lower forms met with on the surface of the sea in the tropics are in no wise less extensive than those met with in high latitudes. It will be found that the lower the grade of being, the more equally balanced will be its distribution at the extremes of the globe; inasmuch as the greater range in depth commanded by these lower forms renders them less amenable to conditions which are variable from being dependent on atmospheric changes.

The composition of the waters of the ocean is well known to become much more equable at great depths; and it, therefore, exercises a far less marked influence on the presence of animal life than it does at the surface.

Oxygen is essential to the presence of animal life; without it animal life ceases. To creatures inhabiting air, or water, a due supply of this gas is indispensable. But although oxygen enters largely into the composition of both atmospheric air and water, the supply of this element is not obtained, in the case of creatures inhabiting the sea, under ordinary circumstances, from its decomposition, but from a certain portion of atmospheric air present in water in a state of solution. Most gases are absorbed by water. Under pressure, the quantity absorbed is much increased, as is seen in the familiar case of soda-water. It should be borne in mind, however, when the fact is applied to the occurrence of animal life at great depths in the sea, that, in order to produce the absorption of atmospheric air, its contact, or mixing together at the surface by the action of wind and wave, is necessary; and the effect of this operation can only extend to a limited depth, unless, as has been assumed by some of our highest authorities, the lower strata of sea-water, being subject to increased pressure, become capable of holding in solution a greater quantity of oxygen, and, by robbing the superincumbent strata of that which they contain, gradually become saturated with it. Should this view be correct, there must be a point at which the maximum amount of oxygen which sea-water can absorb is permanently present in it. But, inasmuch as the vegetable cell, simple though it be in structure, can eliminate carbon from the medium in which it lives, it is not unreasonable to assume that the lowest forms of animal life, even where no specialized organs are traceable, may, in like manner, be able to eliminate oxygen directly from the water around them.

The temperature of the sea is materially influenced by the climatic conditions of different latitudes, and, of course, exercises a powerful effect both on the distribution and abundance of the higher orders of living beings present in its waters. But this influence is not so manifest in the lower orders; for, at greater depths, the variability of the temperature is reduced within very narrow limits in all latitudes. Now, the higher orders of oceanic creatures inhabit only the surface waters, never sinking down to extreme depths. In the case of some of the lower forms, on the other hand, a very extended bathymetrical

range exists, putting out of the question those which constantly dwell on the sea-bed itself, of which I shall presently have to speak.

In like manner light, or rather the absence of it, can hardly be said to determine, in any important degree, the distribution and limitation of the lower forms of animal life. Light is not essential, even in the case of some of the higher orders. A large class of creatures, both terrestrial and marine, possess no true organs of vision, although there is good reason for believing that they do possess some special sensorial apparatus, susceptible to the influence of light.

It is impossible at present to say to what depth light penetrates in the sea. The photographic art will, no doubt, one day solve the problem. But it is almost certain that a limit is attained, and *that*, moreover, long before the deep recesses gauged by the sounding machine are reached, where the light-giving portion of the ray cannot penetrate, even in its most attenuated condition; and yet, as shall hereafter be shown, creatures have been found down in those profound and dark abysses whose coloring is as delicate and varied as if they had passed their existence under the bright influence of a summer sun!

Pressure is the last condition which has to be noticed. Although undoubtedly a highly important one, I hope to be able to prove that it is not of essential value, as has heretofore been laid down, in determining the final issue of animal life in the sea.

It is almost needless to state that, at the sea level, there exists a pressure of fifteen pounds on every square inch of surface, due to the weight of the atmospheric column resting upon it; and that the pressure on the successive strata of water in the sea, as the depth increases, is infinitely in excess of this, inasmuch as a column of water only thirty-three feet in height is capable of counterbalancing the entire atmospheric column, which extends to a height of about forty-five miles. Accordingly, for every thirty-three feet of descent in the sea, putting out of consideration the effect of the superincumbent column in actually diminishing the bulk of the portions beneath by augmenting their density, there is an additional fifteen pounds. At great depths, therefore, the aggregate pressure becomes stupendous. As is well known, pieces of light wood let down to a depth of fifteen hundred or two thousand fathoms become so compressed and surcharged with water as to be too heavy to float. But there is a fallacy in this experiment; for the contraction of the woody fibre and cells is a necessary consequence of their submission to an amount of pressure so enormously in excess of that under which they originated. With organisms which have been developed, from first to last, under the full operation of any given amount of pressure, the result would not be of this nature; for the equalization of the pressure, within and without their entire structure, although it might possibly exercise some definite effect in determining their shape, size, or even functions, cannot, I submit, operate in causing the creatures living under it to experience any more detrimental results than we experience from the fifteen pounds on every square inch, or about fourteen tons on the general surface of our bodies, near the sea level.

It can scarcely be wondered at, that, under such apparently extraordinary conditions, the maintenance of life, even in its least developed aspect, should have been deemed absolutely impossible at ex-

treme depths; and that it should have been almost unanimously recognized as an axiom, that at a depth of four hundred, or at most five hundred fathoms, life, whether animal or vegetable, must be extinct. The fact is unquestionable, that, as we descend beyond the first hundred fathoms, the traces of life become more and more remote; and it is probably owing to this gradual diminution in the number of animal forms, as the depth exceeds this limit, that it has been assumed, rather as a matter of theory than of observation, that a point is speedily reached at which all the conditions essential to life are extinguished. This view has also derived support from the idea that "animal life depends on the previous existence of vegetable life." In the case of the higher orders of the animal kingdom, the law no doubt holds good. Not so, however, in the case of the lower. The conditions essential to the perpetuation of the one are not essential to the perpetuation of the other. Thus, light is indispensable for the healthy respiration and growth of the vegetable. The animal can, on the other hand, respire as freely in the blackest darkness as in the broad glare of day. And this is no doubt the reason why vegetable life in the ocean attains its final limit in depth so much sooner than animal life.

The *Foraminifera* are the organisms to which reference has been made as performing so very important a part in the formation of certain strata on the earth's crust. They occur abundantly in all existing seas, and in almost all marine sedimentary strata, as chalk, limestones, etc. In the mud "irooze," which is brought up from great depths in many parts of the ocean, immense numbers of Foraminifera are to be met with, chiefly belonging to one species. The question as to their occurrence in a living or dead state, however, was overlooked or undecided. Most authorities who have written on the subject are of the opinion that they do not live at great depths, but that their shells and remains have drifted to the positions in which they were found from shallower waters, or have subsided from the upper strata of the ocean. Professor Huxley was one of the very few who leaned to the more correct opinion; he having declared that, although far from regarding it as proved that the Globigerina (the species referred to) live at these depths, the balance of probabilities seemed to him to incline in that direction.

The difficulty is, how to determine the point conclusively; for it seems legitimate to infer that, if these organisms are specially adapted to exist under conditions differing so widely from those present at or near the surface, the very circumstance of removing them from one set of conditions to the other would inevitably destroy their vitality, and perhaps their normal structure, before it could become practicable to subject them to microscopic analysis. Nor is the difficulty an imaginary one. For, taking into consideration the entirely altered circumstances in which these creatures must find themselves placed when brought to the surface, locomotion, or even the protrusion of their filamentary appendages, could hardly be expected. The mere existence of the fleshy parts within their shells, and that too in an apparently recent condition, affords no proof, inasmuch as the great quantity of saline matter present in sea-water, and especially

at great depths, would, of itself alone, account for their perfect state of preservation.

During the recent survey of the North Atlantic I found that, in certain localities where the Globigerina deposit was of the purest kind and in the greatest plenty, the specimens from the immediate surface stratum of the sea bed alone retained their normal appearance, both as regards the perfect state of the sarcodic contents of the shells and the presence of the pseudopodia. The latter organs were never seen by me in an extended condition, but, in the specimens alluded to, and in those only, occurred as minute bosses, resembling in shape the rounded rivet-heads on boilers, closely appressed to the external surface of the shell; whereas, in specimens from the sub-stratum, the color was much duskier, and these bosses were absent. And, further, in these pure deposits the shells were to be found in every gradation, from the single chamber, of microscopic minuteness, hyaline transparency, and extreme thinness, to the dense zeolite-like structure of the many-chambered mature shells, which are large enough to be readily distinguished by the naked eye. These facts, when taken in conjunction with the entire absence of the varied remains of other organized structures found in localities where the Globigerinæ are only scantily represented, afford, as I conceive, all but the direct proof, which can only be arrived at on witnessing locomotion, or the protrusion and retraction of the pseudopodia of the organisms in question.

Most fortunately, as it happened, this collateral evidence was rendered doubly conclusive by other proofs of a most unexpected and interesting kind. Before entering on these, I may state that the substratum, spoken of as differing in aspect from the immediate surface-layer, is nevertheless identical in composition; the difference in color arising simply from decay. It contains no living Foraminifera; for the minute particles of matter becoming gradually condensed and aggregated together by molecular affinity, and the enormous superincumbent pressure exerting itself only in one direction, that is, vertically, its permeability by fluids is thus completely destroyed, and it is compacted into a dense mass of far too unyielding a nature to admit of its being traversed by living creatures of any kind. As the Foraminifera die off, their shells and decaying contents, together with the minute particles of amorphous matter associated with them, go to build up the calcareous strata of the earth's crust. I would mention that, in order to determine whether the Globigerinæ live as free floating forms in the mid-strata of water, I attached a small open-mouthed bag, at about two hundred fathoms from the extreme end of the sounding-line, in a locality where the species was most abundant in the deposit, and brought it up through nearly five thousand feet of water, without securing a single shell.

But by far the most important and interesting discovery remains to be noticed, namely, the detection of a high order of radiate animal, in a living state, at a depth of a mile and a half below the surface of the sea.

In sounding midway, in the direct line between Cape Farewell, the southern point of Greenland, and the north-west coast of Ireland, in lat. 59° 27′ N. and long. 26° 41′ W., the depth being twelve hun-

dred and sixty fathoms, or two thousand five hundred and twenty yards, whilst the sounding apparatus itself brought up a considerable quantity of minute granular particles, looking like a fine oölite, but which was, in reality, a nearly perfectly pure Globigerina deposit, thirteen star-fishes, from two inches to five inches in diameter from tip to tip of rays, belonging to a genus plentifully represented on our own coasts, came up adhering to the extreme fifty fathoms of sounding-line. These *Ophiocomæ* were not only alive on being brought up out of the water, but some of them continued for fully a quarter of an hour to move about their long spinous arms. To render intelligible the significancy of the entire circumstances, I must mention that, in order to insure accuracy, it is always necessary, when sounding in deep water, to ascertain the depth by one sort of apparatus, and to bring up the sample of bottom by another. In the present case, the ascertained depth was twelve hundred and sixty fathoms, and fifty fathoms was accordingly "paid out" in the second operation of bringing up bottom, in order to make sure that the more complicated and unmanageable apparatus required for this purpose fairly rested on the bottom.

Now, supposing it possible that these star-fishes were drifting about in some intermediate stratum of water, between the bottom and surface, it is evident that they would have attached themselves indiscriminately to any portion of the entire twelve hundred and sixty fathoms of line; unless, indeed, they chanced to have been directing their course in a closely compacted column, which was traversed by the last extra fifty fathoms of line at the precise moment of their crossing it. Whether it be possible that they were drifting in such a column, or floating on a bed of sea-weed or other substance, is immaterial, inasmuch as they could only have attached themselves as they did to the portion of line referred to under this one condition. But the very act of attachment would, I maintain, be impossible in the case of creatures whose movements are so sluggish, when the object which they had to grasp was moving upwards at the rate of two miles per hour (as it does when hauled up by the steam-engine), and without a moment's intermission. But even assuming it to be possible that they had drifted to the position in which they were captured from distant and less profound depths, the fact of their vitality and vigorously healthy condition would be scarcely less extraordinary; for the distance from the nearest point of land, which is a rock off Iceland, is two hundred and fifty miles, whilst the next nearest land, Greenland, is distant no less than five hundred miles. But it must be obvious to every one who is at all conversant with the structure of the *Ophiocomæ* and Echinoderms generally, that they are essentially creeping and crawling creatures, and of far too great specific gravity to float at all under any circumstances.

Taking into consideration then the circumstances under which these *Ophiocomæ* were taken, the extreme improbability of their having drifted to the locality in which they were found from distant and shallower waters, and, lastly, the peculiarities of structure which render them wholly unfit to float or swim for even a brief period, we should have been fully warranted, I think, in believing that they existed in a living state at the bottom. In order to obtain some clue

to the solution of the question, I very carefully dissected and analyzed the contents of the digestive cavity of a specimen, immediately on its being brought up; and was most amply repaid by the detection of numerous *Globigerinæ* in every stage of comminution, and with the contained sarcodic matter in greater or less quantity. Whilst, therefore, the detection of these organisms in the digestive cavities of the *Ophiocomæ* afforded a most conclusive proof that the Foraminifera were living on the sea-bed at the profound depth from which they were obtained, the fact of the star-fishes being captured with the fresh remains of the Foraminifera in their digestive cavities proves that their normal habitation is at the same great depth, inasmuch as it has been sufficiently established that the *Globigerinæ* are present only at the bottom. I may also mention that, in examining a sample of the Globigerina deposit, brought up by a previous sounding on the same spot, I detected some Echinoderm spines, which at once struck me as being identical with those on the *Ophiocomæ*, and that, on comparison, my surmise proved to be quite correct: a further and very striking proof of the vitality of the *Ophiocomæ* at the bottom being thus afforded.

Professor Agassiz, at a recent meeting of the Boston Society of Natural History, in commenting on the existence of marine animals at the great depth of twelve hundred fathoms (seven thousand five hundred and sixty feet), as demonstrated by Dr. Wallech in the preceding paper, remarked that, in order to withstand the pressure to which these animals must be subjected, without being crushed, he maintained that water must penetrate their tissues very freely. The fluid penetrates in fishes through minute pores communicating with the venous sinuses near the heart; these are to be seen by the naked eye on the sides of the head of the herring and shad, and enable these fishes to make the change from deep water in the winter to shoal water in the spring, when they approach the shore to spawn. In mollusks they are limited chiefly to the foot; in echinoderms they vary in different families, being sometimes in slits, and at others admitting water into the aquiferous system through the madreporic body.

PHYSICAL AND PHYSIOLOGICAL PROCESSES INVOLVED IN SENSATION.

The following interesting paper on the above subject was read before the British Association, 1861, by Dr. J. D. Morrell: —

Every one knows that when an appropriate stimulus is applied to any of the organs of sense, a feeling is produced in the mind which is termed, in the language of mental science, a sensation. A pin driven into any of the nerves which extend themselves immediately under the surface of the skin produces pain; a ray of light falling on the retina produces vision; a sapid substance put into the mouth produces taste, and so forth. Now it has always been a puzzle among mental philosophers to understand how it is that we can come to a consciousness of external objects at all. Theories without number have been formed, from the time of Plato downwards, to bridge over the gulf which lies between matter and consciousness, between objects

of sense around us and the fact of sensation within us. The chasm in our knowledge we do not pretend wholly to fill. At the same time, so many facts bearing on the question have been brought to light by the progress of physical science on the one side, and by physiology on the other, and so much has been added by the mental analyst, likewise, from his peculiar point of view, that the distance between the outer world and our own inner consciousness has been vastly diminished, and the mystery driven back to that one point of connection between the brain and the human soul which no analysis appears likely fully to solve. Let us attempt, then, to strip away all that is mixed up with sensation naturally, and all that is added to it by our subsequent mental activity, so as to analyze the bare fact itself, and reduce it to its simplest elements.

Looking to the physical and external parts of the process, we must consider, first of all, what it is that the nerves convey from the world without to the mind within. Let us take as an example the sense of hearing, as presenting the greatest degree of simplicity. We know, from the investigation of physical science, that the sole medium of sound is the atmosphere. Where there is no atmosphere there can be no sound, and where the atmosphere is perfectly still, perfect silence is the necessary result. The real cause of sound, therefore, externally considered, is found in the motion of the atmosphere; and the variations in the acuteness or gravity of sound, we know by experiment, arise from the greater or less rapidity of the oscillations. The deepest note which the human ear appears capable of perceiving as a continuous sound is that produced by sixteen oscillations in a second; the acutest, that which is produced by about forty-eight thousand oscillations in the same time. The differences in the quality of sounds arise, in like manner, from the peculiar way in which the atmosphere is affected by the object that sets it in motion, and the corresponding peculiarity of the atmospheric waves that reach the ear. What we really *sensize*, therefore, through the ear is simply the motion of the atmosphere, and nothing more. The human ear is an apparatus beautifully formed for receiving the vibrations on which all sound depends, and the auditory nerve conveys them, in some manner, to the sensorium. With regard to the way in which this latter effect is brought about, we have as yet very little insight. The soft texture of the nerves, and the manner in which they are imbedded in the surrounding materials, would naturally suggest a total inaptitude for propagating vibrations in the ordinary sense of that term. It seems more probable that the flow of life through the body is accompanied with a constant thrill and movement in every part of the nervous system, forming what is technically termed the cœnæsthesis, or common sensibility, so that the outward oscillations do not so much originate wholly new vibrations as enter into conflict with the nervous action already going on, and give it that peculiar determination which is necessary to create any given sensation in the mind. This is perhaps as far as it is possible to go in our analysis of the physical process. How the vibration of the air comes into conflict with the living thrill of the nerve, and how the result of this conflict reaches the mind, we are at present unable to comprehend. It is one of those hidden secrets of nature which science has not yet been able to unfold.

Turning from the sense of hearing to that of sight, a precisely similar analysis holds good. Here the vibrating medium is not the atmosphere, but a universally diffused ether, which is set in motion by what are called luminous bodies. Just as atmospheric oscillations form the external cause, and sound the internal result, in the case of hearing, so, in sight, the oscillations of the light-bearing ether form the outward condition, and color, in all its various shades, the inward result. Here, accordingly, as before, it is simply motion in nature giving rise to motion in the nerve-world, with which we have immediately to do in vision; while, to keep up the analogy, it is the difference in the rapidity of the oscillations that creates all the infinite variations of hue. The red rays, it is calculated, require four hundred and fifty-eight billions of oscillations in a second, the violet rays seven hundred and twenty-seven billions, and all the other colors and shades of the spectrum some intermediate number. That the phenomena of sound and sight spring physiologically out of particular states of the corresponding nerves is clear from the fact that pressure on the eye, or any artificial irritation, produces the perception of light as strongly as the normal impulses derived from the vibrating ether, and that any artificial excitement of the auditory nerve will produce noise in the head. Ghost-seeing often arises in the same way; that is, when the conditions of sight are brought about by the nerves being affected through some other than the ordinary and legitimate stimuli. Whatever, in a word, can affect the regular vital movements of the nerves, and put them into a condition at all similar to that produced by the proper external stimuli of sensation, will of necessity bring about similar phenomena of consciousness.

We come next to the sense of feeling. This sense comprehends two apparently distinct series of sensations, namely, those of touch, properly so called, and those of heat. With regard to the latter, it has been pretty well established that the phenomena of heat originate in the oscillations of a subtle fluid similar to that of light. The sensation of heat may, therefore, be brought under the law of motion just as much as that of light or hearing, and may be regarded in every respect as analogous. The phenomena of touch, we know, are produced by impact in various ways; and it is just in accordance with the nature of that impact, whether harder or softer, more rapid or more slow, that the resulting sensations are determined. A blow is a sudden affection produced by the rapid motion of some object against a considerable surface of the body. Pressure is a more continuous affection of the same kind. A prick is the motion of some object against one minute point of the skin. If the act of pricking be repeated rapidly, it produces a feeling of burning, and, if it be very soft at the same time, of itching. An extremely light and gentle motion over the body produces tickling. In every instance the peculiar kind of sensation is determined by the nature of the motion and the consequent impact.

The only two senses left, accordingly, are those of taste and smell. In both these cases the process by which the nerves are affected is of a chemical nature. The substances received upon the surface of the tongue or the internal membrane of the nostril are subjected to the action of saliva or mucus, and, being thus dissolved, produce a chemi-

cal action on the nerves, which gives rise to the phenomena of taste and smell. All chemical action, however, arises, as far as it can yet be ascertained, from certain relative movements in the ultimate atoms of bodies, and it is these movements, which, in the case of taste and smell, really give rise to the peculiar sensations so designated. One striking proof of this is, that the similar atomic action can be produced by magnetism, and that various tastes, particularly that of phosphorus, can be produced by the introduction of magnetic plates into the mouth; thus most obviously proving that the phenomena of taste are really produced, like those of heat, by the motion of certain minute particles, whether of some magnetic fluid, or of anything else, when subjected to chemical action. By these atomic movements the nerves are affected, just as they are affected by the infinitesimal oscillations of light and heat; so that the same law holds good throughout, and thus enables us to connect the phenomena of sensation universally with motion as its immediate external antecedent and exciting cause.

Looking now from the physical side of sensation to the mental, we shall find that the view we have just taken solves or dissipates many of the difficulties in which the question has always seemed to be involved. First of all, it makes the external cause and the effect upon the nervous system quite homogeneous. Outward motion is the cause, inward motion is the effect. Instead of having the solid forms of the outward world standing as it were face to face with the nervous energy, and being obliged to consider how it is possible for two things so entirely heterogeneous to come into so close a state of mental action and reaction, we have now the whole problem reduced to two developments of motion: first, motion in the fluids around us; and, secondly, a certain determination given, by their means, to the atomic movements or vibrations of the nerves. How the movements of the nerve-force are converted into those of mind-force, we cannot say, any more than we can explain how it is that mechanical motion is converted into heat, or *vice versa;* but the outward phenomena are traced, in the way we have now indicated, as far back to the inward consciousness as seems possible, without breaking through the last film of separation that divides the conscious from the unconscious world.

Secondly. The theory we have adopted enables us to draw a clear line of separation between sensation (properly so called) and all the subsequent mental phenomena which attach themselves to it. Thus, taking the sense of hearing, we can now easily strip away every possible association which connects itself with what we hear, and understand that the sensation of hearing itself simply implies the nervous effect of certain atmospheric vibrations, and nothing more. Taking the sense of sight, we can at once negative the possibility of sensizing size, shape, thickness, distance, or any other of the properties of bodies; all we see sensationally is color, as being the direct result in the consciousness of the luminous vibrations which affect the optic nerve. And so, in like manner, does every sense confine itself to one single and peculiar series of phenomena, which are not by any means to be confounded with the mental acts and associations afterwards connected with them.

Thirdly. The same theory introduces unity into the entire sphere of sensational phenomena. The whole of these phenomena are reduced to the simple principle of motion, as the invariable antecedent; this motion, as it exists in external nature, exciting a corresponding action in the nerves, and then, through the nerve-force, affecting the mind. Thus then we find, by the combined aid of physics and physiology, (1) that man possesses a nervous system, pervaded by a force which can pass freely from every point in the human system to the centre, and from the centre to every point in the circumference; (2) that he is placed in a universe palpitating with countless millions of vibrations, of which vibrations the nerves of the different sense-organs are directly susceptible; (3) that the whole connection which the mind has, or can possibly have, with the external world, is formed by the motion of the fluids around us, or the motion of the particles of bodies that come into chemical contact with the nerves; (4) that the material universe, therefore, makes itself known to us entirely through the medium of motion; (5) that this motion expresses itself in the nervous system by modifying the regular vital action which is always going on there; and (lastly) that this modification of the nerve-force manifests itself to our consciousness in the varied phenomenon of what we term sensation. Thus the world communicates with the consciousness wholly through motion as a link of connection, and out of the experiences thus formed our whole intelligence is subsequently built up by the laws of mental development.

PHYSIOLOGICAL RESEARCHES ON THE ARTIFICIAL PRODUCTION OF CATARACT.

The following is an abstract of a paper read before the British Association, at its last meeting (1861), on the above subject, by Dr. Richardson: —

Medical science, up to the present time, has been based almost exclusively on the analytical method of research; but recently physiologists have added greatly to a knowledge of disease by attempts to induce diseases in animals of an inferior order. This method has been arranged and formularized by the author under the title *Study of Disease by Synthesis*. Experimental researches on the artificial production of disease have been instituted by Bernard, on diabetes; by Brown-Séquard, on epilepsy; by Weir, Mitchell, Kunde, and the author, on cataract; and by the author on rheumatism and endocarditis or inflammation of the heart.

In this paper Dr. Richardson confined his observations to the synthesis of cataract. He explained that Dr. Mitchell, in making some experiments with frogs, had discovered that by the exposure of a frog to simple syrup, cataract was the result. The author had repeated and largely extended this inquiry, and had produced cataract in frogs by various sugars and by salines. He had further ascertained that the same results could be obtained in warm-blooded animals, and had determined that any soluble crystallizable substance present in the blood in such quantity as to raise the specific gravity above the normal standard would produce the cataractic condition. Several frogs were now exhibited by the author, showing induced cataract

in various stages. The condition was temporary, and would pass away slowly as the agent producing it left the system of the animal. Different substances produced different characters of the cataract: thus, cataract produced by salines was harder than that produced by sugar. All the soluble blood-salts present in the blood in excess, produced the same condition. Having thus described the production of cataract, Dr. Richardson showed its connection with disease by the fact that diabetes — a disorder in which sugar is present in excess in the blood — is attended in one in every four cases by cataract more or less developed; and it is probable, although not as yet demonstrated, that there were other diseased conditions in which saline constituents by excess induced the same condition in the human subject.

The last point to be considered was, why does the crystalline lens undergo opacity? Many years ago, Sir David Brewster, at a meeting of the Association, had pointed out that the opacity of the crystalline lens in cataract depended upon disarrangement of the fibres of the lens; but the reason of the disarrangement had not been explained, neither had Sir David's view, though quite correct, been generally accepted. The experiments conducted by Dr. Mitchell and the author proved that the opacity, which ordinarily commences in the back part of the lens, is due to an irregular clustering together of the fibres, and to external softening. This change is brought about by osmosis, or transference of water from one body to another. He, the author, as well as Dr. Mitchell, had, in his earliest inquiries, arrived at this conclusion; but the nature of the osmotic act was now more fully developed by the recent researches of Dr. Graham on liquid diffusion. Dr. Graham had divided all bodies into two great classes, the colloids and the crystalloids. The former, represented by gelatine, are constantly undergoing change and yielding up their water; the latter receive and fix water: hence, in contact, in water, the crystalloids will become universally distributed, while the colloids will separate. The crystalline lens is a true colloid, containing in health a certain given portion of water, upon the presence of which its transparency depends. But whenever there is such a deviation in the blood, in the amount of crystalloid, that that amount is increased, the colloid structures undergo a derangement, owing to an abstraction of the water which they contain. This is what occurs to the lens in cataract, a disease which becomes, by this explanation, a physical phenomenon of the simplest class.

RESUSCITATION.

The following interesting paper was read before the British Association (1861) by Dr. Richardson: —

It has been conceived by many of the eminent physicians of past times that a day would come when a knowledge of life would be so far advanced that, after certain forms of death in which the organic structures of the body were not injured, such as deaths by suffocation, by some poisons, by shock, and the like, it would be possible to produce re-animation. This, which was formerly but an idea, is now, by the course of physiological research, almost a reality. Death,

in the cases which the author considered proper for attempt at resuscitation, was defined as a condition in which both the beat of the heart and the force of respiration had entirely ceased, and in which the animal, if left alone, would pass into putrefaction and dissolution. There was a limitation as to time after death during which the means of resuscitation could be applied with a chance of success. This time was limited by one of two occurrences: coagulation of the blood in the vessels of the body, and putrefaction of the tissues. The first of these events rarely occurred, in cases of death such as has been described, within twenty minutes; the second was often deferred as many hours. A perfect means of resuscitation ought, therefore, to be successful up to at least a period of twenty minutes after death.

There are four methods at present known by which endeavors have been made to produce re-animation: — 1. Artificial respiration. 2. Galvanism. 3. Injection into blood-vessels. 4. Artificial circulation.

Artificial respiration is almost a certain means of restoration when the action of the heart has not stopped; but if the heart has ceased, then the process, however long continued, is of no avail, inasmuch as the column of blood which should be passing from the heart to the lungs is checked, and no blood is presented to the air which the patient is made to inspire. The author gave the results of sixty experiments in which he had employed common air, and of several other experiments in which different substances, such as oxygen, chlorine, oxy-hydrogen, and ozone, had been mixed with the air used; but in all these cases the results were negative, because the action of the heart had stopped. There was, nevertheless, this great fact to be remembered, that in instances where the respiration had ceased, the influence of artificial respiration in restoring the failing heart is materially increased by making use of an air heated to 130° Fah. Dr. Richardson therefore suggests that in all receiving houses for persons who may have been drowned, or accidentally killed by other means, a hot-air bath should always be kept ready, in which the patient should be at once placed, and the air of which should be used for artificial respiration.

Galvanism, as applied to purposes of resuscitation, was first used by Aldini; but the galvanic current was generally applied in a very empirical manner. The two important points to be solved were, (*a*) whether galvanism could be used to start the respiration? (*b*) whether it could be used to start the heart after that had stopped? The author had made numerous inquiries on these points, and came definitely to the conclusion that galvanism, however carefully applied, tends to exhaust rather than to restore the heart, and that although it might be made to restart respiration, by directing the current in intermittent shocks through the chest, from the larynx to the diaphragm, yet that the muscular exhaustion it produced exhausted the muscular force more quickly than the mere rest or natural death of the muscle. Dr. Richardson at this point exhibited some newly-constructed apparatus which he had used in his researches.

The idea of injecting fluids into the blood-vessels as a means of restoration was first thrown out in the seventeenth century. Recently

it has been shown by Dr. Brown-Séquard that the injection of blood into the limbs of the dead subject would restore muscular irritability for a long time after dissolution, and even after rigidity: the author had determined himself that three hours after death, in inferior animals, active muscular movements could be excited by the injection of water heated to a temperature of 115° to 120°. The injection of fluids into the blood-vessels (arteries) might, therefore, be turned to account; but there were certain practical difficulties in the way; for if blood were to be used, there would be difficulty of obtaining it in every case, and all other fluids which the author had tried produced too destructive an effect on the blood remaining in the body to prove of effective service. The author had tried the injection of various agents, such as oxygen, peroxide of hydrogen, and certain of these had promised at first useful results, but in the end they had failed from physical reasons.

The last method was described under the term "artificial circulation." This method was invented by the author and named by him. It consisted in an attempt to supplement the forcing power of the heart for a short time by mechanical means, so as to enable him to drive or draw a stream of blood over the pulmonic circuit. The various contrivances and instruments employed in this endeavor were now carefully particularized, the difficulties of the pursuit explained, and the failures accounted for. In one experiment it was shown that, when artificial circulation was established in an animal, the blood traversed the lungs, made its way afterwards over the arterial channels, and reproduced muscular action, and even sensibility. As yet, however, the operation for artificial circulation was too formidable to be used in the human subject: it was, nevertheless, the point to which attention should be specially directed.

Dr. Richardson's conclusions were as follows: In cases of suspended animation, if there is the merest attempt at breathing, place the patient in a very warm atmosphere, but do not meddle further; if respiration has quite ceased, set it up artificially, using warm air for inflation, and continue thus for at least fifteen minutes, for the heart may not have ceased to beat, and if not, the operation will often succeed. Avoid galvanism; it is a deceptive and dangerous remedy.

The great desideratum is an improved method of producing artificial respiration, and so of supplementing the heart.

POSITION OF THE RIFLE NECESSARY FOR ACCURATE FIRING.

It is not absolutely necessary to hold the rifle at the shoulder, to make good practice in firing. In support of this averment we will draw attention to the fact that it is nearly certain that the resistance given to the recoil of the rifle augments the deviations of the bullet; and we will quote a historical account suggesting incontestable proofs in confirmation. The account occurs in the book of Father Huc, apostolical missionary in China, Vol. I. c. 10. It is as follows: — "The fusiliers and archers then practised at the target. Their skill was remarkable. The Chinese matchlocks have no butts, but terminate like a pistol. When they fire they do not hold the matchlock at the

shoulder; they hold it at the right side, at the height of the haunches, and before letting down upon the priming the hook that holds a lighted match, they fix their eyes upon the target. We remarked that this mode of firing was eminently successful, which seems to prove, perhaps, that to fire accurately with the rifle it is less necessary to sight with the top of the barrel than to look steadfastly on the object."

These last words are completely in accordance with facts perfectly admitted, and prove our assertion that it is not necessary to take a line of sight to hit an object, and that it suffices to look at it steadfastly, with a strong will to hit it with the bullet. Thus the stone that whirls in a sling, describing a circle, and escaping at an instant which indicates only an internal instinct; the quoit thrown by one hand, which retires and then advances; the end of a stick, which describes a circle round the shoulder to strike accurately a point suspended in space,—are all instances in point, to which we must add the Australian boomerang in its incomprehensible gyrations. In these different examples, the chief point is the attention and intention of the operator powerfully concentrated on the object; and we are led to suppose that by a physiological cause, analogous to that which forces a muscle to bend or extend, the stone, the quoit, the stick-end and the boomerang—through the apparatus of nerves forming the medium of communication with the mind—become, as it were, endowed with the magnetic will of the operator, and obey him as long as the impulse is not victoriously counteracted by gravitation, the resistance of the air, the insufficient initial velocity, and other causes that stop the bullet.

This theory—a direction impressed on a projectile as it were by a sort of magnetic power—seems confirmed both by the example of savages skilled in the use of the bow, and by the practice of the most expert hunters, who content themselves with steadfastly looking at the game,—following its movements with their eyes, then bringing the rifle to the shoulder, and instantly touching the trigger, without taking time to aim. Some years ago, at Paris, there was an exhibition of South American savages and their war exercise. All drew the bow with rare precision,—holding it vertically, the right hand at the haunch, the head erect, and the eye looking steadfastly at the target. And as another example we will quote the description of an English sportsman, given by M. Mangeot, a renowned gunmaker of Brussels: "The English marksman never lowers his head, even before his game fleeing in a straight line. At its departure he full-cocks,—his head erect, so as to follow all its movements with his eye. When he thinks it sufficiently far to allow him to fire at a fair sportsman's distance, he brings the butt of the gun smartly to the hollow of his shoulder, at the same time directing the muzzle to the object, the elbow slightly raised, to preserve the equilibrium of the piece, and without an instant's delay he touches the trigger; so that these two movements are instantaneous."

From the above facts we conclude that it is not absolutely necessary to place the butt to the shoulder, nor to take a line of sight; that it is important to fix the eye on the object at the moment of firing; and that consequently if we wish to hit an enemy situated sufficiently far to require us to aim above his head, if we discard the back-sight (whose use is impracticable in battle), we must then, instead of sighting, place

the butt at the hip, and endeavor empirically at each distance to incline the arm to the proper elevation before firing. — *Gen. Bonneau de Martray.*

THE QUESTION WHETHER THE HAIR IS OR IS NOT SUBJECT TO SUDDEN CHANGES IN COLOR.

The following is an abstract of a paper on the above subject, read before the British Association, 1861, by Dr. John Davy: —

The popular notion is decidedly in favor of the affirmative, and many naturalists and physiologists have come to the same conclusion. They adduce instances of the change of the hair to white or gray, in the case of persons under strong emotions of grief or terror. Haller, in his *Elementa Physiologiæ*, refers to eight authorities for examples of such changes; but all that he seems to admit for himself is, that under the influence of impaired health such a change may take place slowly. Marie Antoinette was cited, by favorers of the popular notion, as a striking and well-authenticated instance; but when fairly considered, the case came under the condition admitted by Haller. Had it been possible for mental emotion, whether of terror or of grief, to render hair suddenly gray, surely in the queen's case the change should have been witnessed at an earlier period than that of the arrest of the royal family in their attempt to leave France. If such a sudden change could be presumed, might we not expect to witness it in soldiers engaged in an active campaign, amidst all the dangers and horrors of war? He had himself examined thousands of soldiers, — men prematurely worn out in various climates, and concerned in many a hard-fought battle, — many of them grievously wounded; but he never met with an instance of the kind. The case of a rebel Sepoy is stated by Dr. Laycock, on the authority of Surgeon Parry; it being said that the man's hair changed from black to gray in half an hour. He was undoubtedly under the belief that he would be condemned to death. Might not this be the explanation? — the man was hurried in, profusely perspiring; he was naked, and cooling and drying rapidly, his hair, previously gray, being darkened by moisture, resumed its natural color. The effect of water in intensifying color is well known; and a further circumstance in aid of the explanation given may be found in the fact that the natives of Bengal are in the habit of staining their hair. The *Transactions* of the Royal Society, extending over two hundred years, do not contain an instance of such change in the color of the hair, — a circumstance opposed to the conclusion that it ever took place; for had it ever been undoubtedly witnessed it is not likely that it would have remained undescribed. The author is not aware that, irrespective of recorded evidence, anything in support of the popular notion can be adduced on physiological grounds. Human hair cannot be injected. Using coloring fluids, such as a solution of nitrate of silver and a solution of iodine, the author has not observed any change of color, except in the portions actually immersed. Whether it owes its color to a fixed oil, to a peculiar arrangement of its constitutional molecules, or to both, it resists decay in a remarkable manner; it resists the action of acids and alkalies, except the strongest, which dissolve it; it resists maceration, and even

boiling water, except continued for a long time, and under pressure, when it suffers disintegration and decomposition. Exposure to the sun will bleach hair, but this will not account for any very sudden change of color. Supporters of the popular opinion refer to changes in the plumage of birds, such as the ptarmigan, and in the hair of certain quadrupeds, such as the mountain hare and ermine, which become white towards winter, and of a darker hue when the winter is passed. The belief is rested on, that this is not caused by moulting, or a change of coats, but that it takes place in the existing feathers and hair. But there is no satisfactory evidence of such changes; and considering the qualities of both, they seem most improbable. There is good proof that in the ptarmigan the change is decidedly connected with moulting; at least such is the author's decided impression, from inspecting the numerous specimens — shot at different seasons — belonging to Mr. Gould, which eminent ornithologist says that the "ptarmigan is always moulting," the changes being from brown in the summer to speckled in the autumn and white in the winter. The speckled feathers, few and large, overlap the white, and as soon as those few are shed the bird appears in its white dress. The similar change amongst quadrupeds most probably arises from the same cause; and examples, less striking than those amongst wild animals, can be observed in cases of the horse and the cow. Prof. Rolleston, of Oxford, had given to the author a portion of the hair of a pony which has been observed to change its coat from tawny to nearly white, in winter. Mr. Erasmus Wilson, who advocates the popular doctrine, refers to the case of a lemming, in support of his views; but Mr. Blyth, a naturalist, says he examined a lemming killed during its autumnal change, and satisfied himself that "the white hairs were all new, and not the brown changed in color." There are reasons why it might be expected that the summer coat and plumage should be darker than those of the winter.

The author concludes that, whether we consider one side of the question or the other, — the human evidence so questionable, the physiological so much more reliable, — the idea of fallacy is unavoidable as to the hair being subject to sudden change of color from mental impression. The attempts made to explain such a change by physiologists are allowed to be complete failures; and more amusing attempts had been made to explain the phenomenon on other grounds than those of fallacy. The author, when on foreign service, knew an assistant surgeon of a regiment who had become insane, and whom he visited a fortnight or three weeks subsequently. The patient's hair, before brown, had become gray; but when he called attention to the fact, the regimental surgeon simply said, "Your surprise will cease when you know that —— has, since he has been afflicted with his malady, discontinued dyeing his hair." When we consider how prone the hair of some persons is to turn gray at an early age, even without accompanying or preceding bodily ailment, and how many would wish to conceal this blemish, and so have recourse to chemical means, it is easy to imagine that this source of error may not be unfrequent. Nor should it be overlooked that there is a disposition in some to make statements merely for the sake of exciting momentary surprise, or of acquiring ephemeral notoriety. If we consult the rec-

ords of imposition and delusion, we shall find many a thing attested, and for a time believed, of as marvellous a kind as the sudden whitening of the human hair.

POSSIBLE ULTIMATE CAUSES OF DISEASE. — BY M. C. LEA, ESQ.

There are, perhaps, few branches of medical science which are surrounded by so many difficulties, or in which so little has been accomplished, as the investigation of the ultimate causes of disease. The subject offers a wide field for study, which would, no doubt, well reward the time and labor which might be expended upon it. Raspail, in spite of his eccentricities, made some curious and ingenious observations and suggestions, though he doubtless erred in looking too far for his causes, and referring too much to remote and insufficient agents, such as inhalation of sporules, seeds, etc., and ingestion of particles acting hurtfully by mechanical agencies, and other similar accidents. Those to which it is here proposed to refer are in their nature obscure and difficult of recognition, but of sufficient gravity to explain all the effects which may be supposed to arise from them.

It is possible that there may exist abnormal states of the system, in consequence of which the digestion of certain aliments may take place in an abnormal manner. It is not here intended to refer to indigestion, which, in many cases, may even be a wholesome and beneficial effort of nature to prevent the assimilation of a particular kind of food which the actual condition of the body may render injurious, but to an action of a very different character. Food which may, in normal conditions of the body, yield products of digestion of the most nutritious and wholesome character, might equally, in certain unfavorable conditions of the digestive system, yield more or less active poison, which, though generated in very small quantity, may gradually go on with a slowly increasing toxical effect, until the whole system is disordered by it. Disordered digestive functions of this kind may perhaps be the key to many of those inexplicable changes of health, in which the system is gradually broken down without any visible cause.

One or two examples will be sufficient to illustrate the author's meaning, it not being his intention to enter upon speculations belonging less to chemistry than to chemical physiology, but rather to suggest how much invaluable information might be obtained by subjecting parts of the body after death by disease to a rigid chemical analysis, with a view to detect the presence of poisonous substances generated in the body itself out of aliments innocuous in a normal condition of the functions of digestion.

Butyric Acid. — This acid is an active poison. M. Isidore Pierre mentions a case reported to the Agricultural Society of Caen, in which a number of horses had suffered severely by drinking water out of a certain pool, two of the number having died in consequence. The analysis of the water of this pool, which was in the neighborhood of a farm-yard, proved the existence of butyric acid in a saline form in it; and other similar cases were ascertained. No other substance could be detected in the water which could have had a poisonous

effect upon the animals. Some cider which had proved very injurious to the health of those who had used it, was found, on examination by M. Pierre, to contain considerable quantities of butyric acid, but no other substance to which the bad effects could be ascribed.

There is no reason to doubt that butyric acid might, under abnormal circumstances, be produced in the body in considerable quantity. Many substances which, under normal digestive functions, may be favorably assimilated, might, in peculiar states of the body, scarcely amounting in themselves to absolute disease, be converted into butyric acid, which, according to Leopold Gmelin, is produced under the following circumstances: —

Starch and sugar, in contact with proteine substances, are gradually converted into butyric acid, with or without previous conversion into lactic acid. Grape sugar in solution, which does not of itself ferment, may be made to do so by immersion of bits of paper previously exhausted by chlorhydric acid and water, with production of butyric acid. The residue from the manufacture of potato starch, which contains considerable quantities of starch, if mixed with small quantities of animal matter, undergoes fermentation in two or three days, with production of butyric acid. Large quantities of the same acid are formed when starch remains in contact with animal matters for a few days, and under other circumstances which might occur in the human system.

In confirmation of this view, it may be mentioned that butyric acid has actually been detected in the gastric juice, and in the matter from a cancer in the stomach. Butyric acid may even be in very small quantity an occasional or even normal constituent of certain parts of the body. But, under unfavorable conditions of the digestive functions, it may easily be produced in sufficient quantity to exercise a noxious influence on the organism.

Butyric acid is, in all these cases, an oxidation product, as is proved by the fact that the same substances, starch, sugar, gluten, etc., yield it by treatment with nitric acid, sulphuric acid, and peroxide of manganese, or chromic acid. If, therefore, it could be demonstrated that any particular form of disease was occasioned by the presence of butyric acid, such disease might, no doubt, be successfully combated by deoxidizing agents, such as sulphur baths.

CONFORMATION OF THE TEETH IN THE INFERIOR VARIETIES OF MAN.

The conformation of the teeth in the inferior varieties of man presents some curious approximations to the dental structure of the ape. In the latter, the pre-molars, or bicuspids, are implanted by three fangs. In the Caucasian race of man they generally have, seemingly, only one fang, which, however, consists of two more or less completely united; but in negroes these teeth have two distinct fangs. "It is only in the black varieties," says Professor Owen, in his admirable paper on the teeth, "and more particularly that race inhabiting Australia, that I have found the wisdom tooth with three fangs as a general rule; and the two outer ones are more or less confluent." In most of the black varieties of man, especially the Australians, "the

true molars attain larger dimensions than in the yellow or white races," and, as well as in the apes, are supported by two distinct fangs; whereas, in the white and yellow races of the human subject, these fangs are not infrequently united in the second molar, and are usually so in the third. Just in proportion as the teeth of the black races diverge from the Caucasian form, they approach, it will be observed, the dental organization of the apes.

INFERIOR TYPES OF THE HUMAN RACE.

There is reason for believing that one of many missing links between existing European races and the highest apes has recently been discovered in Germany, in the shape of a very ancient skull, together with part of the skeleton to which it belonged. The account of this interesting relic was published by Prof. D. Schaaff'-hausen, of Brun, in *Müller's Archiv*, 1858, and has been translated and published, with remarks, by Mr. George Busk, F. R. S., in the *Natural History Review*, No. 2. It appears that in the early part of 1857 a human skeleton was discovered in a limestone cave, in the Neanderthal, near Hochdal, between Düsseldorf and Eberfeld. "The uneven floor of the cave was covered to a thickness of four or five feet with a deposit of mud, sparingly intermixed with rounded fragments of chert. In the removing of this deposit the bones were discovered." The value of these remains was not, of course, appreciated by the workmen, and hence several parts of the skeleton were lost. Even the skull is not perfect. The peculiarity of the skull consists in a remarkable prominence or projection of the super-ciliary region of the forehead. The enlargement in this part is so great that it can hardly be described as limited to the super-ciliary ridges. These ridges, which coalesce completely in the middle, are so prominent that the frontal bone exhibits a considerable hollow or depression above, or rather behind, them, whilst a deep depression is also found in the situation of the root of the nose. The forehead is narrow and low, though the middle and hinder portions of the cranial arch are well developed. The other bones which were procured along with the skull are characterized by their unusual thickness, and the great development of all of the elevations and depressions for the attachment of muscles. Professor Schaaff'hausen remarks: —

"There is no reason whatever for regarding the unusual development of the frontal sinuses in the remarkable skull from the Neanderthal as a pathological deformity; it is, unquestionably, a typical-race character, and is physiologically connected with the uncommon thickness of the other bones of the skeleton, which exceeds, by about one-half, the usual proportions." Owing to the imperfection of the skull, it is difficult to determine the facial angle correctly. Professor Schaaff'hausen estimates it at 56°, whereas Mr. Busk, who estimated the angle on a cast of the skull, makes it from 64° to 67°. "The cranial capacity, compared with the uncommon strength of the corporeal frame, would seem to indicate a small cerebral development." Both Professor Schaaff'hausen and his translator are struck with the approach which the frontal bone of this skull presents to the cranial conformation of the chimpanzee and gorilla, in respect both to

the enormous projection of the super-ciliary region, and to the depressed forehead. Prof. Schaaff'hausen sums up his conclusions as follows: —

"First. That the extraordinary form of the skull was due to a natural conformation hitherto not known to exist, even in the most barbarous races.

"Secondly, That these remarkable human remains belonged to a period antecedent to the time of the Celts and Germans, and were, in all probability, derived from one of the wild races of north-western Europe, spoken of by Latin writers; and which were encountered as autochthones by the German immigrants. And,

"Thirdly. That it was beyond doubt that these human relics were traceable to a period at which the latest animals of the diluvian still existed; but that no proof in support of this assumption, nor, consequently, of their so-termed fossil condition, was afforded by the circumstances under which the bones were discovered."

Mr. Busk observes that these remains "were discovered under circumstances which, though not altogether demonstrative of their real geological position, leave no doubt of their enormous antiquity, and of the probability of their having belonged to what has been termed the quaternary period. The conformation of the cranium, moreover, in this instance is so remarkable as justly to excite the utmost interest, approaching as it does, in one respect, that of some of the higher apes."

Although the skull above described exceeds all others yet known in approximation to that of apes, many skulls have been found which occupy a position between this one and existing forms.

"In a bone cavern in Brazil, Lieud discovered human crania mixed with the bones of extinct animals, in which the forehead receded on a level with the face; a formation which is also represented in ancient Mexican pictures. In the rocky caverns of the Peruvian Andes, Casteluan discovered, under the same conditions, human crania of a similar, strongly retrocedent, elongated form. . . . .

"In the *Transactions of the Imperial Russian Mineralogical Society* of the year 1842, an account was given, by Dr. S. Kutorga, of two human skulls from the government of Minsk. . . . One of the skulls there figured presented a great similarity with that found in the Neanderthal. . . . A human skeleton, in a squatting, or almost kneeling posture, together with implements made of bone, a battle-axe of stag's horn, two boar's tusks, which had been cut off, and three incisor teeth of a stag, perforated at the root, were found near Place, in silicious sand, six feet below the surface. A very high antiquity was assigned to this grave, as it was wholly unprotected by any masonry, and afforded no trace of cremation having been practised, nor any implements of stone, clay, or metal. Dr. Lisch, who had been struck with the unusual prominence of the supra-orbital border, the wide root of the nose, and the strongly retrocedent frontal, accompanied the account of the finding with this remark: 'The formation of the skull indicates a very remotely distant period, at which men presented a much lower degree of development. Probably this grave belongs to the autochthonous population.'"

Accounts of many other primitive skulls are given in the very in-

teresting paper of Professor Schaff'hausen, and, as he justly observes, afford "one of the most striking proofs of the influence of culture and civilization on the form of the human skull." The Abbé Frère, whose collection of crania, belonging to the different centuries of our epoch, is now placed in the Anthropological Museum of the Jardin des Plantes in Paris, came to the conclusion that in the most ancient crania the occipital was the most, and the frontal region the least, developed; and that the increase in the elevation of the latter marked the transition from barbarous to civilized man.

NEW THEORY RESPECTING THE QUEEN BEE.

Professor Leitch, an eminent European naturalist, has announced a new theory on the queen bee, a puzzle which has exercised the wits of naturalists and philosophers for many ages. How is a queen bee produced from an egg which, under ordinary circumstances, would produce a sterile worker? It is commonly supposed that this change is effected by the supply of a peculiar food (a "royal jelly," it has been termed) to the larvæ. Professor Leitch considers that the change is effected by an increase of the temperature of the cell containing the larvæ intended for the production of a queen bee, and that the object of the isolated position of the royal cell is to admit of its being surrounded by a cluster of bees, who, by their rapidly-increased respiration, produce the warmth necessary to accomplish the growth of the queen.

RESEARCHES UPON SPONTANEOUS GENERATION.

The theory of spontaneous generation, advocated by M. Pouchet, of France, and others (see *Annual of Scientific Discovery*, 1860, pp. 391–401), has been opposed by most scientific authorities, on the supposition, mainly, that the minute organisms obtained by apparent spontaneous development were really derived from microscopic germs, floating in the air, so small that they are introduced into the experimental apparatus, despite all precautions taken to exclude them. To definitely prove the existence of these germs, M. Pouchet has submitted atmospheric air, under a great variety of conditions, to microscopic examination. He has not found, however, either germs or spores of infusoria in the dust suspended in the air, but he has found a great number of grains of starch. The air of great cities, and other inhabited places, contains many of these starch grains, which, according to him, one might take to be eggs of infusoria, or germs of mucedines (fungi). Yet M. Pasteur has proved that there must be something in the air besides these starch grains, for, by causing a quantity of air to pass through a tube containing calcined asbestos, into liquids which previously had been exposed to air which had been calcined, and which consequently contained no trace of vegetation, he was able to develop mould, or vegetation. When calcined asbestos, unexposed to air, was alone introduced, no vegetation appeared.

The apparatus used by M. Pasteur is remarkable for its simplicity and precision, and its results, says M. Nickles, prove the impossibility on the part of nature to continue her creative work in connection

with elements purely mineral, or to animate them with the organic influence.

M. Pasteur further informs us that, in order that vegetation may be developed, or fermentation produced, there must be a liquid containing water, a salt having ammonia as a base, a carbonaceous substance, and a phosphate: air is necessary only for the moment while we introduce into the flask some spores of *penicilium*, or a little of the calcined asbestos exposed to air by the process indicated above. The mycodermic (mouldy) vegetation is then developed in less than a day; and, what is particularly remarkable, it is developed in the dark as well as in the light. The ordinary law does not govern these little organizations, for they neither give out oxygen nor absorb free carbonic acid; but, on the contrary, they disengage carbonic acid, and increase by fixing ammonia and phosphoric acid. The germs which produce these marvellous effects are not uniformly distributed in the air; thus Pasteur, making comparative experiments with one and the same liquid arranged in flasks completely deprived of air, found that the air from the cellars of the observatory contained only one-tenth part as many germs as the air from the court of that establishment; and that the air contained fewer germs in proportion to its elevation in the atmosphere. This chemist has performed comparative experiments in the mountains of Jura, at an altitude of eight hundred metres, and in the Alps at Montanvert (Savoy), at two thousand metres above the level of the sea; and he has proposed to take the air from a much greater elevation by the aid of a balloon.

The following, in brief, are the conclusions which seem to be satisfactorily deducible from Pasteur's experiments: —

1. That the air of inhabited places contains a greater relative number of fruitful germs than the air of uninhabited regions.

2. That the ordinary air contains only here and there, without any continuity, the condition of the first existence of generations sometimes considered spontaneous. Here there are germs, and there there are none.

3. There are few or many, according to the localities. Rain diminishes the number, but after a succession of fine days they are more numerous. Where the atmosphere has been for a long time quiet, germs are wanting, and putrefaction does not take place as in ordinary circumstances.

Gay Lussac, Schwann and Pouchet have performed various experiments upon liquids in contact with common air, with heated air, with artificial air, and with oxygen gas, using a mercurial bath to isolate the substances experimented upon. Some of their results have appeared to favor the theory of spontaneous generation. Pasteur has ascertained that mercury taken from the bath in any laboratory is itself loaded with organic germs. He took a globule of mercury, surrounded by an atmosphere of calcined air, and passed it into a flask of putrescible fluid by the process detailed in the former part of this paper. In every experiment of this kind, after two days, an abundant growth of organic products appeared.

The same experiments were repeated with the same liquids, with no change of manipulation, with the same kind of mercury, except that the mercury was first heated to destroy the germs it contained, and no growths whatever appeared in the flasks.

Pasteur, from these results, therefore, concludes, that germs suspended in the air are the exclusive origin, and the first and necessary condition, of life in infusions, in putrescible bodies, and in liquids capable of undergoing fermentation.

The generally received theory of ferments, if we admit the truth of M. Pasteur's conclusions, is furthermore incorrect, inasmuch as a ferment is not a dead substance without determinate specific properties, but a being whose germ is derived from the air. It is not, moreover, an albuminous substance altered by oxygen; but the presence of albuminous matters is an indispensable condition of all fermentation, because the "*ferment*" depends upon them for its life. They are indispensable in the light of an aliment to the ferment. The contact of the atmospheric air is, primarily, equally an indispensable condition of fermentation; but it is indispensable only as being a vehicle for the "*germs*" of the "*ferments*." There are, moreover, many distinct organized ferments which excite chemical transformations, varying according to the nature and organization of the ferment.

The researches of Pasteur also present an interesting field to the naturalist. He has noticed many species in vegetation, new and hitherto unknown. By varying the conditions, it will doubtless be possible to obtain others. On the publication of his (Pasteur's) researches, Boussingault called attention to a fact pointed out by Bineau, of Lyons, who, while examining a specimen of rain-water, containing nitrates and ammonia in solution, found these materials disappearing under the influence of cryptogamic vegetation.

Conclusions of importance to the agriculturist have also been recently made known in connection with the above noticed researches. Thus, in order that plants may be developed in atmospheric waters, these waters should be found in the condition of Pasteur's liquids. It is known that rain-water contains assimilable nitrogen and also salts of potash, soda, lime, etc., but it has heretofore lacked the indispensable element, phosphoric acid, which had never been detected in rain-water. This chasm in the series of fertilizing principles of meteoric waters, has at length been filled by Barral, who has discovered phosphates in rain-water. To avoid all sources of error, this chemist has experimented entirely with an apparatus of platinum. In the residue of evaporation he has obtained the phosphorus in the condition of phosphoric acid, as phosphate of bismuth (Chancel's process) and as an ammoniaco-magnesian phosphate. He has thus found a quantity of phosphoric acid, varying from .05 to .09 of a milligramme to a litre of rain-water = 0.000.5 to 0.000.9 gram).

From these results it may be calculated that the rain-water of an ordinary shower furnishes about four hundred gram's of phosphoric acid to the French *hectare* (or two and one-half English acres). Now, since the researches of Boussingault have proved that a hectolitre (two and three-quarter bushels) of wheat takes from the soil about one kilogramme of phosphoric acid, we see that to obtain seven or eight hectolitres of wheat to the French *hectare*, which corresponds to a harvest without the use of manure, it would be necessary to let the field repose for twenty years, if the soil did not previously contain a trace of phosphates. — *Compiled from Silliman's Journal.*

ASTRONOMY AND METEOROLOGY.

NEW PLANETS.

Ten additional asteroidal planets have been discovered during the past year, making the whole number now recognized *seventy-two.*

The sixty-third asteroid was discovered February 10, 1861, by M. de Gasparis, at Naples, and has received the name *Ausonia.*

The sixty-fourth, discovered by M. Tempel, at Marseilles, March 2d, has received the name *Angelina.*

The sixty-fifth, discovered by M. Tempel, March 4th, has received the name *Maximiliana.*

The sixty-sixth, discovered April 9th, by Mr. H. P. Tuttle, of Cambridge, has received the name *Maia.*

The sixty-seventh, discovered April 17th, by Mr. N. R. Pogson, at Madras, India, has received the name *Asia.*

The sixty-eighth, discovered April 29th, by M. Luther, at Bilk, Germany, has received the name *Leto.*

The sixty-ninth, discovered April 29th, by Dr. Schiaparelli, at Milan, has received the name *Hesperia.*

The seventieth, discovered May 5th, by M. Goldschmidt, at Paris, has received the name *Panopea.*

The seventy-first, discovered August 13th, by M. Luther, at Bilk, has received the name *Niobe.*

The discovery of the seventy-second asteroid is thus spoken of by Mr. T. H. Safford, of the Cambridge (Mass.) Observatory: —

"I found, when revising some of my own observations, that Dr. Peters and myself had been (at the last) observing different bodies, under the impression that each of them was Maia. Calculation at once showed that the Doctor had found a new one, not knowing it; and the elements which were derived from his observations showed with much probability that this new asteroid was quite a remarkable one, being in fact nearer the earth than any other yet known. This conclusion may be modified when more details of the observations are published. It seems that the original Maia must have become too faint for the Hamilton College telescope (which is somewhat smaller than the Cambridge), and that the stranger was picked up as being near the same place. This is the fourth or fifth instance in which small planets have been discovered by accident, and the second in which the discovery has been shown only by calculation.

Peculiarities of the known Asteroids. — The asteroid which is nearest the sun is Flora (mean distance 2.20), with a period of 1193

days. The asteroid most remote from the sun is Maximiliana (mean distance 3.45), with a period of 2343 days; so that the extreme asteroids differ more between themselves than the orbit of the earth does from that of Venus or Mars.

The asteroid whose orbit has the least eccentricity is Concordia (eccentricity 0.04); that which has the greatest eccentricity is Polyhymnia (eccentricity 0.337). The orbit of Faye's comet has an eccentricity of only 0.556; so that in respect of eccentricity, the asteroids differ more among themselves than they do from the comets.

The asteroid whose orbit is least inclined to the ecliptic is Massillia (inclination 0° 41′); that whose orbit is most inclined to the ecliptic is Pallas (inclination 34° 42′).

Re-discovery of Pseudo-Daphne. — August 27, 1861, M. Goldschmidt, of Paris, re-discovered the planet which he discovered Sept. 9, 1857, and which has received the name of Pseudo-Daphne. The history of this planet is very remarkable. On the 22d of May, 1856, M. Goldschmidt, discovered a new planet of the eleventh or twelfth magnitude. He observed it again on the 25th; but on neither occasion was he able to locate the planet accurately, for want of suitable instruments. On the 31st it was observed at Marseilles; it was observed at Berlin, June 1st, 2d, and 3d, and it was observed at Vienna, June 2d and 4th. The planet, being now quite faint and difficult to observe, was no longer followed; so that the reliable observations only embrace an interval of *four days,* and the arc described in this interval was but little more than *one degree.* From this small arc it was required to deduce the elements and compute an ephemeris for the planet's return to opposition in Sept. 1857.

M. Pape, of the Altona Observatory, computed the best orbit he was able from these observations, and published an ephemeris for the approaching opposition. Anticipating the difficulty of finding the planet, the astronomers at Oxford, Paris, Berlin, Vienna, Altona, and Bilk agreed upon a joint search, each observer selecting a portion of the heavens which he would specially explore.

Sept. 9th, 1857, M. Goldschmidt, of Paris, announced that he had re-discovered Daphne, only about two degrees from the place assigned by the elements of Pape. The planet was afterwards observed at Bilk, Leyden, Bonn, Berlin, and Cambridge, and was followed till Sept 30th. On computing the orbit from the observations of 1857, it was found that the elements differed very materially from those which M. Pape had obtained; and indeed these new elements would not represent the places of Daphne in 1856 within more than twelve degrees. This discrepancy was first announced by M. Schubert, in Sept., 1858; and he, of course, concluded that the planet discovered by Goldschmidt Sept. 9th, 1857, and which was supposed to be Daphne, was *not* Daphne, but a new planet. M. Goldschmidt accordingly gave the new planet the name of *Pseudo-Daphne.*

M. Luther, at Bilk, made a careful computation of the orbit of Pseudo-Daphne, and published an ephemeris for the next opposition in December, 1858, but *the planet was not found.*

M. Luther again computed the planet's place for the succeeding opposition in March, 1860; but as, on account of its distance, its brightness should be only one-fourth of its brightness in Sept. 1857,

there was not much encouragement to prosecute the search, and the planet was not seen in 1860. He, however, remarked that at the next opposition in August, 1861, the planet should appear of the 10 . 11th magnitude, or somewhat brighter than in 1857, and he accordingly published an ephemeris to guide astronomers in their search for it. The planet was discovered by M. Goldschmidt, Aug. 27th, 1861. Its observed place differed from the computed place about ten degrees of arc. This error is not very great, when it is considered that the planet's place was computed from an arc of *less than four degrees, described four years previous.* It is presumed that Pseudo-Daphne will not again escape from the watchful eye of astronomers; but Daphne seems entirely lost, and can only be re-discovered by the same systematic search by which it was discovered in 1856.

Nomenclature of new Planets.—At a recent meeting of the French Academy, M. Leverrier brought forward the idea of ceasing to give classical names to the new asteroidal planets, as he considered their number to be necessarily indefinite; and therefore there must be a limit of classical names. If we must some day change our system, why not begin at once? Mr. Hind, the English astronomer, however, dissents from this proposal of Leverrier, and at the same time strongly objects to such names as *Angelina*, or *Maximiliana*, which, he says, ought to be rejected on the ground of impropriety.

NEW FAMILIES OF ASTEROIDS.

In 1859, M. Leverrier presented an interesting paper to the French Academy, on certain irregularities in the motion of the planet Mercury. These, carefully studied, led him to the curious conclusion that the planet's motions were disturbed by a quantity of matter revolving between it and the sun. Believing that if this matter had existed in the form of a planet it could not have escaped notice, he concluded that it must be distributed in a group of small bodies, like the asteroids, circulating between Mars and Jupiter. In confirmation of this idea, he found that Lemonnier, in 1772, saw, under some peculiarly favorable circumstances, a ring or chaplet of small bodies cross the sun's disc, occupying some minutes in doing so. Further researches, submitted to the public during the past year, have enabled him to advance a step farther in the path of discovery thus opened up.

Leverrier observes that from the action of the planets on each other, their orbits are subject to changes of three kinds. There may be a change in the *plane* of a planet's orbit, or the angle it forms with the ecliptic; secondly, in its *orientation*, or the part of the heavens to which its longer axis points; and, thirdly, in its *form*, or the shape of the ellipse described by the planet. Now, the amount of such changes, ascertained by observation, affords data for computing the masses of the bodies producing them; and if we assume that the known planets are the only disturbing bodies, it follows that the results obtained—the value of the masses—should be the same, whatever be the changes from which the computation is made. If the results do not exhibit this harmony, the discordance indicates the action of some body exterior to the planets, which has been overlooked. It was in this way, from the difference between the observed and computed

longitudes of Uranus, that the disturbing action of an unknown planet (Neptune) was ascertained, and, by marvellous refinements of calculation, its very place in the heavens pointed out.

Entering into a comparison of the results afforded by the separate study of each one of the planets, M. Leverrier finds that the position and small size of Mercury and Mars prevent them from exercising any important influence upon the bodies of our system. Observations upon Venus enable us to estimate the mass of Mercury as one five-millionth ($\frac{1}{5000000}$) of that of the sun; while the motion of the earth, deduced from observations of the sun, indicates the mass of Mars as one three-millionth ($\frac{1}{3000000}$) that of the sun. The uncertainty which may exist in these numbers has no influence upon that which follows.

The mass of Venus is not far from one four-hundred-thousandth ($\frac{1}{400000}$) that of the sun. The result is obtained by several methods: by the consideration of the displacement of the plane of the ecliptic; by the actual measurement of the periodical perturbations of the earth from 1750 to 1810, and from 1811 to 1850; and by the amount of the periodical inequalities of the longitude of Mercury. These results all confirm each other.

The mass of the earth is one three-hundred-and-fifty-five-thousandth ($\frac{1}{355000}$) of that of the sun. This number is derived from a comparison of the force of gravity upon the earth, with the fall of our own planet toward the sun.

Setting out from these data, the French astronomer finds that, to reconcile the ancient with the modern observations of Mars, it is necessary to accelerate his perihelion movement. To find an adequate cause for this, again, we must assume an increase in the attractive force of the earth or Venus, that is, in the computed mass of one or both of these planets. But the action of Venus on Mars is, from its position, comparatively feeble; and the value of its mass rests on grounds that are considered unassailable. We have no alternative, then, but to add to the computed mass of the earth, and an addition of *a tenth* suffices. But there are good reasons against admitting such a change; and an equal quantity of matter, in another form, revolving round the sun at the same distance, will give us the attractive force required.

As already remarked, the study of the inequalities of Mercury led Leverrier, in 1859, to the inference that a ring of masses of matter existed within the orbit of Mercury, or between it and the sun. His reasons for believing that the disturbing cause in the case of Mercury was a ring of small masses of matter, rather than one large body, were, that a single planet comparable to Mercury, as regards its dimensions, and revolving within its orbit, could not have escaped the recognition of astronomers, especially during the total eclipses of the sun. On the other hand, says Leverrier, if the cosmical disturbing matter has such a disposition, that, although partly or wholly invisible, it acts in such a manner as to increase the direct motion of the perihelion, having but little influence apart from this, it is easy to see how the existence of matter in this connection becomes highly probable. This, in fact, is the mode of action of a series of small bodies forming a ring about the sun, and revolving from west to east, in the

same direction as other planetary bodies. These bodies, as a whole, could scarcely change the eccentricity of the orbit of a planet, or cause any sensible periodic inequality in the longitude. Their effect upon the perihelion, however, might become considerable, since it is the sum of the separate effects of each one; so that the final result is sensibly the same as if the whole amount of matter was concentrated in a single mass. "Such," says Leverrier, "are the considerations which have induced me to admit the existence of a ring of intra-Mercurial asteroids."

Returning now to the consideration of the irregularities of Mars, Leverrier finds that they can all be satisfactorily explained by supposing, as in the case of Mercury, a ring of asteroids to exist within the orbit of Mars, at a distance from the sun equal to the distance of the earth from the sun, and having a *total mass* equal to a tenth of that of the earth. This group of asteroids would accelerate the motion of the perihelion of Mars, just as an addition of a *tenth* to the mass of the earth would do. If it is situated very nearly in the ecliptic, it will produce the same effect upon the orbit of Venus, and therefore explain certain irregularities in the motion of the latter planet.

Finally, from the consideration of these and other data, Leverrier announces that he has arrived at the following conclusions: —

1st. Besides the planets, Mercury, Venus, Earth, and Mars, there exists between the sun and Mercury a ring of asteroids whose mass is comparable with the mass of Mercury itself.

2d. At the distance of the earth from the sun is found a second ring of asteroids, whose mass is not greater than the tenth part of the mass of the earth.

3d. The total mass of the group of small planets situated between Mars and Jupiter is not greater than the third part of the mass of the earth.

4th. The masses of the last two groups are complementary to each other. Ten times the mass of the group situated at the distance of the earth, plus three times the total mass of the small planets between Mars and Jupiter, form a sum equal to the mass of the earth.

The last conclusion depends upon the determination of the distance of the earth from the sun by observations of the transits of Venus, a determination which astronomers agree in considering as very accurate.

In regard to the hypothetical ring of planetary bodies encircling the earth, M. Leverrier bases his opinion on purely astronomical grounds, and he makes no allusion in his paper to a phenomenon which will at once present itself forcibly to many minds, namely, the aerolites falling from the atmosphere. For the last twenty years it has been all but universally admitted that these falling masses were of the nature of planetary bodies; but there was nothing in the mode or time of their occurrence to indicate that they had any connection with one another, or with any known part of our solar system. They seemed as independent, and to defy calculation or prediction as much, as the non-periodical comets, without having the marks of brotherhood which these display. Leverrier's discovery, therefore, comes opportunely to give us some idea of their origin. The aerolites, it may be

presumed, are *stragglers* from the ring or circular belt of stones revolving round the sun, and consist of individual blocks, which, during their revolution, happen to come near enough to the earth to be detached from their places by its attraction. Judging from the specimens which visit our globe, these travelling stones must amount to many millions,. since, in the aggregate, they are equal to one-tenth of the earth's mass. It may be assumed that the orbit in which they move has a different plane from that of the earth, and, if so, the fall of aerolites can occur only at the points where the planes intersect, that is, *periodically*, and twice a year at most; while, as their orbit, like the earth's, must be elliptical, and the ring of meteoric stones may not be entire, but consist of detached portions, it is evident that many years may elapse without the earth encountering one aerolite, while, on other occasions, it may encounter many in a single year.

If M. Leverrier's conclusions are accepted, they extend the science of astronomy in its more minute features, and make us acquainted, by an indirect, but ingenious and refined process, with two multitudinous systems of small planetary bodies, of which otherwise we never could have obtained any knowledge.

NEW FACTS AND THEORIES RESPECTING METEORS.

Several points of interest, bearing on the question of meteors, have recently been deduced from a large Catalogue of Fire Balls and Aerolites, published in the British Association Reports for 1860.

First, there appear to be indications of an eight-yearly maximum and minimum period for aerolitic meteors, the calculated years of maxima being 1859, 1851, 1843, 1835, etc., and very nearly agreeing with observed years. Secondly, there appear to be aerolitic and meteoric epochs both distinct from and common to each other. Thirdly, while the aerolitic class of meteors in its total is rather under the average for August, which is the principal and most constant month for an abundance of sporadic meteors, it is over the average for November, likewise a month noted, though not so regularly, for an abundant display of meteors. Fourthly, as regards the observed direction of aerolitic and first-class meteors, there would seem not to be any very great tendency one way or the other; it might have been more natural to have expected a much more decided leaning to a westerly direction. The sudden change from an easterly direction, in September and October (about the time of the autumnal equinox), to a westerly direction in November, is remarkable. In January the prevailing direction was S. E.; in February, E. N. E.; in March, N. N. W.; in April, W.; in May, N. W.; in June, S.?; in July, N. W.; in August, W.?; in September, E. N. E.; in October, E. S. E.; in November, W. N. W.; and in December, S.? Fifthly, there have been far more falls of meteoric stones in the months of June and July than in the months of December and January. Sixthly, taking the whole year, there is a greater tendency to equality of distribution in the aerolitic class of meteors than the smaller shooting stars and sporadic meteors; and it is highly probable that there is a distinction to be allowed between these two classes as regards orbit and physical characters. The meteors for December appear of late

to be on the increase. Several days or periods in the year appear to have been rich in aerolitic and first-class meteors. Some of these are, January 2d and 10th; February 6th and 18th; March 1st and 7th; April 19th; June 1st and 2d; July 17th and 29th; August 3d, 7th, and 12th; September 10th; October 1st, 3d, and 23d; November 9th–13th, also November 29th; December 8th–13th. With regard to the November period for shooting stars, Mr. Herrick, of New Haven, considers it to be advancing into the year at the rate of three or four days a century, the period of *maximum* being about thirty-three years; Mr. Greg, an English meteorologist, however, considers it may be nearer seventy. If Mr. Herrick is correct, then the November period should again culminate in 1866.

Prof. A. C. Twining, in the November (1861) number of *Silliman's Journal*, gives the following conclusions, as the result of his investigations respecting periodic meteors, and especially as regards the *radiant* of the August meteors: —

First. The position of the radiant is probably capable of a far more exact determination than is ordinarily supposed, or than could have been anticipated.

Secondly. The radiant is apparently subject to a motion of several degrees from day to day, and one which exhibits some remarkable points of agreement in the comparison of one year's position with those of other years.

If asked, says Professor Twining, what this *radiant* is, whose position can be marked so definitely, I reply, — It is not a point of exact apparent divergence of all the conformable meteors, but it is such a point for the great mass, or assemblage of them, so far as one observer can judge; and it is also, under the same visual limitation, the centre of that area within which the others would project back their lines or directions. The process by which it is found has been, in my own case, the following: The first few meteors, say five or seven, determine the locality rudely. Fixing our attention primarily upon this locality, we are soon supplied with some contiguous and very definite flights which cut the area in a line that can be traced and kept in mind. It may be that this line will be shifted laterally by other nearly parallel flights. We next look with interest for other flights crossing the first at right angles, or at a large angle; and, when a few such are obtained, they limit our area to a narrow central space, subject only to slight shiftings one way or another, according to judgment, continually and rigidly exercised in view of the successive flights which can be brought into comparison with it. These flights should not ordinarily be very distant from the central area. In fact, the very *abbreviated* streaks almost in immediate proximity to the radiant are of special value in the determination or the verification. Occasionally, indeed, a meteor will show itself stationary in the very radiant itself. In the year 1855, on the night of August 10th, such a stationary meteor appeared and almost instantly disappeared in the spot to which my sight was directed, with a peculiar effect, as if a new fixed star had suddenly begun its existence, and as suddenly ended it. Not many minutes after, a second came and went, with a like singular and bewildering effect; and, while I was in the act of pointing out its exact position to a fellow-observer,

(Mr. Francis Bradley), a third drew from us both a simultaneous exclamation. This remarkable consecution of a phenomenon against which there were so many chances, and against the repetition of which, in such a brief space, the chances were so many millions of millions, satisfied me that multitudes of undiscovered meteors were in play over us, but for some reason not seen except when their flight was directed exactly to the observer. If this was the fact, a telescope *truly pointed to the radiant*, would have discovered yet more stationary points of brightness. Such an attempt, if successfully made, and ascertained to be ordinarily practicable, would realize this remarkable advantage, that, by employing the telescopes of graduated instruments, *our radiant positions might be defined with certainty, and with some rude approach, at least, to astronomical accuracy.*

For any considerable advance upon our present knowledge of meteors and meteoric rings, we are clearly dependant upon accurate systematic and concerted observations. Even a casual observation of the principal meteor of a late meteoric display, made coincidently, although without concert, by observers at New Haven and at Burlington, N. J., has seemed to prove, even upon the rudest attention, that the meteors of November and the meteors of August are independent and distinct in their origin or source. The circumstance that upon certain definite days in August of each year, and in November of many years, observers will surely be rewarded with abundant opportunities and subjects for their attention is, of itself, one inestimable encouragement to concert and assiduity.

Professor Twining ventures the opinion that, beyond a definite limit of the earth's atmosphere proper, there exists a secondary or external atmosphere, possibly of aqueous vapor; that in this external medium the shooting stars become visible, and that a knowledge of its upper limit may be obtained by considering and comparing the upper limit of the meteors' paths. It has long been his *suspicion*, to say the least, that some of the irregularities or specialities in meteors' flights are to be explained by their encountering a sudden change of medium from a secondary or exterior atmosphere to the atmosphere proper.

Prof. H. A. Newton, in a communication to *Silliman's Journal*, Nov., 1861, on the "August ring of meteors," says: —

The well-established fact that the meteors of August 9–11 move in paths which, produced backward, pass through a small region of the heavens, and that this region of emanation remains the same, or nearly the same, from year to year, implies, —

1st. That the individual meteors are cosmical bodies.

2d. That they are permanent members of the solar system revolving about the sun in *elliptic* orbits.

3d. That the direction and velocity of the relative motion, and, therefore, of the absolute motion, of the individual bodies are nearly the same.

4th. That the whole group form what may be considered a ring, or disc, around the sun. The region of emanation has not a great length in the great circle through it and that point of the heavens to which the earth is moving. Hence the velocities of the individual meteors of the same year and of different years are nearly the same.

The region of emanation has not great length in the great circle through it and the sun. Hence the tangents to the individual orbits make nearly the same angles with the sun's radius vector.

It follows that the elements of the individual orbits are nearly the same, and hence the probable conclusion that the meteors form a ring and not a disc of great breadth in its own plane. If the breadth is very large, we must conclude that the great part of these orbits which cut the earth's orbit belong to a limited zone, or ring, in the disc. The mean velocity and direction of motion of the August meteors would give an elliptic orbit about the sun which would represent the ring. The velocity of a single member of the group, and the mean place of the radiant, give approximate data for determining this orbit.

Calculations based on these data give for the ring's semi-major axis, 0.84; for its ellipticity, 0.28; its perihelion distance, 0.60; its inclination, 96°, and the periodic time, 281 days. The thickness of the ring is five to ten millions of miles; for the earth, moving nearly two millions of miles a day, is immersed in it during several days.

A rude estimate of the number of individuals in the ring may be formed. Several observers in one place in the morning hours of Aug. 10–11 see at least one hundred and fifty meteors, of which over three-fourths are conformable. Assume the average *perpendicular* distance of the paths of visible meteors from the observers to be not greater than seventy-one miles. This implies that not less than one hundred and twelve meteors pass through a circle of one hundred miles' radius, the circle being at right angles to the relative motion. The velocity is so great that the earth's attraction is not of much account in making the number seen greater than the average throughout the ring. Reducing 112 by the ratio $v' : v''$, and calling the cross section of the stream not less than the area of a circle whose radius is 2,500,000 miles, we have at least $(2{,}500{,}000)^2 \times 112v' \div (100)^2 v''$ meteors passing the node per hour. In 281 days, the periodic time, we have more than 300,000,000,000,000 bodies for the whole August ring.

New Views on the Nature and Origin of Meteorites.—Prof. J. Lawrence Smith, in an article contributed to *Silliman's Journal* (Jan., 1861) on the Guernsey County (Ohio) meteorite, states that he has, from the physical and chemical data collected by him respecting meteorites, arrived at the following conclusions:—

1st. The light emitted from meteoric stones does not arise from incandescence, but from electricity, or some other cause.

2d. That the noise attending their fall is not that arising from the explosion of a solid, but that it is by concussion of the atmosphere, arising from the rapid motion of the body through it, or in part due to electric discharge.

3d. That meteoric showers are not the results of fragments from the rupture of one solid body, but the separation of small and distinct aerolites that have entered our atmosphere in groups.

4th. That the black coating is not of atmospheric origin, but is already formed when these bodies enter our atmosphere.

I would call the attention of those engaged in the examination of this class of bodies to the study of the true nature of their black coating; also to the fact that observers at a distance often see these bodies

in a luminous state, while those situated where they fall do not observe this luminosity.

The proofs upon which these conclusions are founded Professor Smith promises to lay before the public at some future period.

Interesting Indian Meteorite. — On the 14th of July, a meteorite, accompanied by flame and violent explosions, fell at Dhurmsalla, India. The most curious fact connected with this meteorite is, that the pieces which were picked up immediately after they fell were so cold as to benumb the fingers. This is the more remarkable since the *surface* of the meteorite bears marks of having been, a few moments before falling, in a state of fusion. Dr. C. T. Jackson, in presenting a portion of the meteorite to the Boston Society of Natural History, remarks upon the above facts as follows: The temperature of the day was 80°; therefore the cold noticed could not have been the effect of any immediate terrestrial influence. Was it not, then, owing to the low temperature of the region from which the meteorite fell? the interplanetary spaces, according to Baron Fourier's estimate, being about —50° Centigrade, or nearly 100° Fah., below freezing.

Allowing that the meteoric mass came from those regions, the matter being a very slow conductor of heat, we can easily conceive that when the mass entered the earth's atmosphere, it might become heated and inflamed on the surface by condensing the air before it, in its descent toward the earth; and, since it would have to fall through about eighty miles of the atmosphere, the density of which increases as it approaches the earth, the inflammation would take place only where the air had sufficient density, and not in the highest regions. Such being the case, the expansion of the exterior of the meteorite, the surface being incandescent, while the interior was very cold, would cause the mass to fly to pieces with violent detonations, and this, too, quite near to the earth.

The surface of so imperfect a conductor of heat might be ignited, while the interior of the mass remained intensely cold. Therefore there is no inherent improbability that masses of meteoric stone really would produce the sensation of intense cold, if they were originally cold in the interior, and only rapidly heated on the surface. If the facts are as alleged, this is the first recorded recognition by the human senses of the cold of the interplanetary regions.

The meteorites in question so closely resemble the stones which fell, many years since, at Weston, Conn., that they can hardly be distinguished from them.

The Great Meteor of July 20th, 1860. — Mr. Bond, the Director of the Cambridge (Mass.) Observatory, having collected a great number of observations on the great meteor of July 20th, 1860, from all parts of the country included between the north-western lakes and the seaboard, and as far south as Virginia, has come to the conclusion that "this meteor did not belong originally to our system, but must have come to us from the region of the fixed stars, and, after barely grazing the outer limits of our atmosphere, probably passed out of the attractive influence both of the earth and of the sun, with its course considerably changed from its original direction, and with

a velocity somewhat diminished from the resistance encountered in our atmosphere."

THE GREAT COMET OF 1861.

On the last evening of June, 1861, a comet of most remarkable size and brilliancy suddenly made its appearance in the northern hemisphere. It was at first supposed to be the celebrated comet known as "Charles the Fifth's," the reappearance of which has, for some years past, been expected; but investigations soon showed that the celestial visitant had probably never before been observed by astronomers.

The suddenness of the apparition of this comet in northern latitudes was one of the most impressive of its characteristics. On the 29th of June, observations at the Cambridge (Mass.) Observatory failed to detect it; but on the succeeding evening the comet was the most conspicuous object in the western sky. It was, however, discovered at Sidney Observatory, New South Wales, as early as May 13th, and became visible to the naked eye in southern latitudes on the 27th of the same month. "On the 2d of July," says Mr. Bond, of the Cambridge Observatory, "after the twilight had disappeared, the head, to the naked eye, was much brighter than a star of the first magnitude, if only the effective impression be taken into account, although, as to intensity, it was far inferior to α Lyræ, or even to α Ursæ Majoris. I should describe the head as nearly equal in brightness to that of the great comet of 1858, between the 30th of September and the 5th of October.

"The aspect of the tail," continues Mr. Bond, "suggested a resemblance to the comet of March, 1843. It was a narrow, straight ray, projected to a distance of one hundred and six degrees (106°) from the nucleus, being easily distinguishable quite up to the borders of the milky-way. The boundaries, for the most part, were well defined, and easily traced among the stars. Further observations on the tail made it evident that a diffuse, dim light, with very uncertain outlines, apparently composed of hazy filaments, swept off in a strong curve towards the stars in the tail of Ursa Major — the southern edge directed as low as towards Mizar. This was evidently a broad, curved tail, intersected on its curved side at the distance of a few degrees from the nucleus by the long straight ray, which, at the first glance, from its greatly superior brightness, seemed alone to constitute the tail. The two were in fact counterparts of the principal tail and the supplementary rays of the great comet of 1858, with this remarkable difference, that in the latter the straight rays were so far inferior in brightness to the curved tail as to have been recognized at only three observatories, those of Pulkova, Gottingen, and Cambridge, U. S.; while, with the present comet, the predominating feature was the straight ray, to which the curved tail seemed scarcely more than a wisp-like appendage.

"On further scrutiny, with the aid of an opera-glass, two sharply-cut and very narrow dark channels, bounding the principal ray, could be traced for ten or fifteen degrees from the nucleus; while outside of them, on either side, were two additional faint rays. The

whole issue of nebulous matter from the nucleus far into the tail was curiously grooved and striated. It was noticed that both the principal ray and the dark channels penetrated within the outline of the curved tail, the latter being clearly separated from the principal ray, even to the naked eye, by a dark cleft just above their intersection.

"The telescopic phenomena, though interesting, did not present equally strongly-defined features with those which characterized the great comet of 1858. We should, perhaps, except from this remark the structure of the cometary envelopes for a day or two after their first emission from the nucleus. In this stage they were intersected by jets of luminous matter projected from the nucleus, and these limits were pretty clearly outlined.

"On the 2d of July, portions of three were visible; the inner one showing a variety of details. In its outline and general aspect it was like others which followed it, almost a fac-simile, on an enlarged scale, of some of those exhibited by the great comet of 1858. They rapidly faded, or were lost in the surrounding haze, and their places were filled by new ones. Latterly, two, at most, could be seen at one time. It is quite important to remark that the successive envelopes resembled their predecessors not only in their general aspect, but quite closely in the details of their structure; the luminous jets not issuing at random from all points alike of the nucleus, but continuing to follow a nearly similar course at each new discharge from its surface.

"The most natural inference from this would seem to be that the nucleus, if it rotates at all upon an axis, does so very slowly. The nucleus was, throughout, brilliant, and, to appearance, solid, with a diameter of from $2''$ to $3''$."

The investigation of the elements of this comet by Messrs. Safford and Hall, of the Cambridge Observatory, gives the following results: diameter of the nucleus, variously estimated at from one hundred and fifty to three or four hundred miles. On July 2d, the breadth of the head at the nucleus was 156,000 miles, the height of the inner envelope 11,500 miles, and the length of the tail about 15,000,000 miles.

As already stated, Mr. Bond estimated the tail of the comet of 1861 as one hundred and six degrees in length. Father Secchi, the well-known astronomer of Rome, however, estimated it at one hundred and eighteen degrees in length, on the 30th of June. This is the greatest length in arc on record.[1]

Dr. Pape, of Altona, has examined carefully the question whether the earth was at any time within the tail of the comet, and concludes

[1] The clearness of the atmosphere has much to do with estimating the length of comets' tails. In a clear tropical sky the tail may be traced much farther than in English and American skies. The apparent length of comets' tails, moreover, by no means indicates anything of their real length, and it happens that those which appear longest are much shorter than many which do not appear half as long. This is due to the different distances which the comets hold with respect to the earth. While the great comet of 1861 had a tail which stretched farther across the heavens than any previous comet, its real length did not exceed 15,000,000 miles. The great comet of Donati, with a tail of only about half the length in arc, was above 50,000,000 miles in length. The former comet was only 13,000,000 miles distant, while the latter was four times as remote, or about 50,000,000 distant. The great comets of 1080 and 1843 had tails of lengths of 90,000,000 and 180,000,000 miles respectively—the tail of the latter comet being the longest of any comet yet observed.—*Prof. C. W. Tuttle.*

that at its nearest approach we were about 2,400,000 miles distant from its nearest edge, on the morning of June 29th at 2h. 24m.

The above calculations of Pape, says Mr. Bond, in commenting on the above inference, relate to the straight bright ray, which formed the main tail of the comet. But there was, however, in addition, a great mass of diffuse light, which separated from the ray, and swept off towards *Corona Borealis* in the early part of July, reaching on the 4th to a distance of 40° from the nucleus, and having a breadth of 12° or 15°. This would have barely grazed the earth on the 30th of June. In a late number of the *Bulletin of the Imperial Observatory*, at Paris, Mr. Hind suggests that a peculiar illumination of the sky, noticed in England on that date, was possibly "attributable to the commingling of the matter forming the tail of the comet with the earth's atmosphere." The observations on this day have a peculiar interest, from the fact that, at about 10h. mean time, Greenwich, the earth passed the plane of the comet's orbit, and the outline of the tail presented to us was that of the section formed by a plane perpendicular to its orbit.

The orbit of the comet of 1861, according to Mr. Bond, is undoubtedly that of a parabola. It has, therefore, in all probability, never before visited the solar system, and will probably never return to it. Its orbit, moreover, was nearly perpendicular to the plane of the ecliptic, while those of periodical comets usually form a very small angle with that plane. According to M. Leverrier, this comet differs in many respects from any that have been hitherto observed. M. Chacornac, who studied the nucleus of this comet with a powerful telescope, states "that, instead of its being hollow, like the half of an egg-shell, like most of the comets already observed, it presented the appearance of a sun composed of fire-works, the bent rays of which burned in the same sense."

The attempts made to photograph the comet of 1861 were, without exception, failures. Mr. Whipple, the photographic artist of Boston, who, in connection with Mr. Bond, of Cambridge, successfully photographed Donati's comet of 1858, found that the comet of 1861 hardly made an impression on the most sensitive photographic surfaces. Mr. De la Rue, of London, also reports a similar result. He found that an exposure of the sensitive plate to its luminous image in a telescope for one hundred and twenty times as long as sufficed to depict the comet of 1858, entirely failed in giving any trace of an image: the contiguous fixed stars at the same time leaving upon the plate a strong impression. These facts would seem to prove that there was an essential difference between the comet of Donati and that of 1861, in physical constitution, inasmuch as, whilst the luminous rays emitted by them were of almost equal intensities, the actinic rays were almost entirely absent in the light from the latter.

Polarization of the Light of the Comet of 1861. — Father Secchi, of Rome, who examined the comet of 1861 with a polarizing apparatus, with a view of determining whether the body was self-luminous or shone only by reflected light, states that on the 30th of June the polarization of the light of the tail, and of the rays near the nucleus, was very strong, and could be distinguished by the polariscope in bands, while the nucleus itself presented no traces of polarization,

even with Arago's polariscope, with a double-colored image. But on July 3d, and the following days until the 7th, the nucleus, in spite of its extreme diminution, exhibited sensible indications of polarization. Father Secchi considers this fact of great importance, since it thereby appears that the nucleus in the first instance transmitted its own light, perhaps on account of the incandescence to which it was raised by its near propinquity to the sun.

RELATIVE BRIGHTNESS OF THE SUN AND MOON.

The ratio between the light received at the earth from the sun and the full moon has been very differently estimated by two different and eminent observers, namely, Bouguer, a French astronomer, and Wollaston, the well-known English physicist. The former estimated the brightness of the sun to be three hundred thousand times greater than that of the moon; while the latter fixed it at eight hundred and one thousand and seventy-two times greater. This great discordance of results having excited a doubt as to the value of the process followed by the above-named experimenters in working out their problem, Prof. George P. Bond, of the Cambridge (Mass.) Observatory, has, during the past year, re-examined the whole subject, and arrived at new and probably more accurate results than any before attained to.

The method of Bouguer is thus described by Arago: "On the day of observation, the sun being at an altitude of thirty-one degrees, and his rays entering a dark chamber through a hole one-twelfth of an inch in diameter, he placed a concave lens in front of this aperture, which diminished the intensity of the solar rays by causing them to diverge. Then, receiving this divergent light on a screen, at a distance where it was weakened in the proportion of 1 to 11,664, he found it equal to that of a candle situated at the distance of seventeen inches from the screen. Repeating this experiment at night with the moonlight and the same concave lens, the moon being full, and also at an altitude of thirty-one degrees, Bouguer perceived that the light, when it had been made to diverge seven-tenths of an inch, or when it had been weakened only by one sixty-fourth, was already so faint that the candle had to be put at a distance of 53.2 feet before the two lights could be rendered equal. Hence we find by a suitable calculation that the sun illuminates the earth's surface 256,289 times more than the moon does. Three similar experiments, made at various seasons of the year 1725, yielded the following results to M. Bouguer: 284,089; 331,766; 302,500. Whence the celebrated academician concluded that the proportion of sunlight to moonlight, when the moon is at her mean distance, is as 300,000 to 1."

Wollaston furnishes the following account of his mode of procedure:—

"The sun's light was compared with that of a candle, by admitting a beam of it into a room through a small circular hole in a plate of metal, fastened in a window-shutter; and a small cylinder of any opaque material being placed in the beam, so as to cast a shadow upon a screen, the distance of a candle from the same cylinder (or an equal one placed at the same distance from the screen) was varied,

until the shadow in the line of the candle became equally intense with the shadow in the line of the sun. The direct light of the moon was compared with the light of a candle in the same manner."

"In two particulars, which may have exercised a considerable influence," says Mr. Bond, in his memoir presented to the American Academy, "Wollaston's experiments seem to be less deserving of confidence than those of Bouguer, as it does not appear that in the former the extinction of light by the earth's atmosphere was allowed for.

"Another objectionable feature is the means employed for diminishing the sunlight by admitting it only through a very small aperture, while for the moon the full disc was compared. It is not clear that these dissimilar conditions may not have occasioned some disturbance in the results. Bouguer, by using the same aperture upon both objects, has avoided this risk of error."

Furthermore, in comparing the relative brightness of the sun and moon, it is obviously of importance, says Mr. Bond, to vary as much as possible the methods of investigation, in order to render them quite independent of each other, so far as the nature of the subject will permit. The three principal sources of difficulty encountered are, the extreme intensity of sunlight; the difference in color between the light of the sun or moon and that of the ordinary kinds of artificial illumination; lastly, the want of a constant standard of brightness, to which either object may be referred. The best intermediate standard, as regards the quality of the light, would undoubtedly be some form of the electric light, if its constancy could be maintained for a sufficient interval; all other artificial standards having greatly inferior intensity, and a more or less decided red or yellow hue when contrasted with solar light, and even with moonlight, which was scarcely to have been anticipated.

The image of the Drummond light compared with the image of the sun, both reflected from a silvered globe, has a strong golden-yellow hue. The "Bengola" light answers much better. It shows, however, a decided tinge of pink when brought side by side with the pure white of the solar image. At night it is of an intense white, with a bluish glare; but when contrasted with the moon's image, it exhibits a striking similarity in quality of light, with only the very slightest cast of pink at times, suspected of the same character with that noticed in the experiments on the sun, but no trace of the blue can then be detected. It seems, then, that, in point of color, the light of the sun and that of the moon are very nearly similar. After various trials, therefore, the Bengola light was fixed upon by Mr. Bond as the illuminator for comparison, and the following plan was adopted by him in his experiments:—

A glass globe, having a reflecting surface of silver, 10.16 inches in diameter, was placed in the open air, exposed to the sunlight. The brightness of the image of the sun formed at its virtual focus was compared with a single Bengola light, by receiving the light of both objects upon a small reflecting sphere, which was moved towards one or the other until their images, seen in it side by side, were judged to be equal; the distances of the globes from each other and from the Bengola were then measured, and the observation repeated.

The next step was to compare, in precisely the same way, the image of the moon reflected from the silvered globe with a Bengola light of the same size and manufacture. This was done at a time when the moon was nearly full and the sky perfectly clear.

Applying to the respective results thus obtained the necessary corrections (*i. e.*, for atmospheric extinction of light, etc.), Mr. Bond found the average light of the sun to be *four hundred and seventy-one thousand* (470,980) *times brighter than the mean full moon.*

The following table also shows the relative intensity of sunlight and that of other celestial objects, as determined by Mr. Bond:—

Sunlight	=	470,980	times	the light	of	the mean full Moon.
"	=	622,600,000	"	"	"	Venus at maximum brilliancy.
"	=	3,028,350,000	"	"	"	Jupiter at mean opposition.
"	=	5,970,500,000	"	"	"	Sirius.
"	=	18,924,000,000	"	"	"	Alpha Centauri.
"	=	24,946,500,000	"	"	"	Alpha Lyræ.
"	=	25,586,500,000	"	"	"	Rigel.
"	=	52,001,000,000	"	"	"	Spica.

The average light of the full moon, according to Mr. Bond, is six thousand four hundred and thirty (6430) times greater than that of Jupiter seen from the earth at its mean opposition; while Venus, at its greatest brilliancy, is nearly five (4864) times brighter than Jupiter.

Experiments for determining the ratio of sunlight to moonlight, as regards their chemical intensities, give a ratio of three hundred and forty thousand to one.

Observations on the Light of the Moon and of the Planet Jupiter.— In endeavoring to photograph the planet Jupiter on plates exposed at the focus of the great refracting telescope of the observatory of Cambridge, Mr. Bond has found that it (Jupiter) reflects, out of a given quantity of incident light, *fourteen times* more of the chemical rays than the moon does; or, in other words, the latter, if the constitution of its surface resembled that of Jupiter, would photograph in one-fourteenth of the time it actually requires; whereas it was to have been expected, considering the relative distances of the two bodies from the sun, that the light of the moon would have had twenty-seven times more chemical intensity than that of Jupiter, supposing equal capacities for reflection. M. De la Rue, of England, noticed, in 1859, that the chemical rays from Jupiter were twelve times more energetic than those from Saturn,—a result not wholly attributable, in his opinion, to the circumstance of the greater distance of Saturn.

No sufficient explanation of the superior chemical energy of the light of Jupiter can be given. The whiteness, or *albedo*, of the surface of Jupiter exceeds that of the moon, says Mr. Bond, in the proportion of eleven or twelve to one; while the moon bears in this quality a general resemblance to the earth. No opaque substance has been found of a whiteness comparable to the bright belts of Jupiter, or which under similar illumination will shine with the same intensity.

Mr. Bond also notices the changes in the intensity of moonlight at the several phases of our satellite. The brightness somewhat suddenly increases when it approaches opposition, as though a greater number of the reflecting facets of its asperities were disposed in such a manner as to reflect light with the greatest advantage; the effect

being to cause a sudden glance of light analogous to that we may see in micaceous rocks.

It has been observed by De la Rue that the high grounds of the moon's southern hemisphere are more easily photographed than the low lands of the northern hemisphere. The so-called lunar seas are certainly optically as well as chemically fainter than the rest of the surface, and the more rugged and mountainous regions are brighter to the eye just as they are chemically brighter. If the moon were polished perfectly smooth, we should not see its limb at all, but only an image of the sun formed at a virtual focus by reflection from its surface: the visibility of its outline, then, is entirely due to its asperities.

Mr. Bond inclines to the opinion that we have never obtained a view of the solid nucleus of Jupiter; the planet is probably enveloped in a dense mantle of clouds, the luminosity of which may possibly explain its apparent excess of brightness. In our own atmosphere the luminosity of clouds is a well-established fact; and our brilliant auroral exhibitions are also unquestionable evidence that the earth itself shines with a certain amount of native light; it is, therefore, not unreasonable to infer a similar property in Jupiter.

SOLAR ECLIPSE OF 1860.

The following is an account of the great Solar eclipse of 1860, given to the British Association, at its last meeting, by request, by Professor Airy, Astronomer Royal of Great Britain.

He proposed, he said, to commence with a few remarks upon eclipses generally, and he should then state certain observations made in the year 1842 for the first time, and continued up to the present time, and should endeavor to point out the deduction which he thought might legitimately be inferred from them. When first mankind began to observe total eclipses, there was no great difficulty in conceiving that eclipses of the sun were caused by the interposition of the moon; but in a very short time it became obvious that this interposition, which prevented the light from coming to us, was not the interposition of a body at the same distance as the luminous body, but that the circumstance of an eclipse must depend upon other circumstances, namely, the distance of the moon as related to the distance of the sun, and the direction in which the moon was seen as related to the direction in which the sun was seen, by means of the orrery. Professor Airy rendered this plainer by explaining the relative motions of the earth, sun, and moon, and showing the reasons why some eclipses were merely partial, and others annular.

There was a recurrence, he said, in eclipses of a very singular nature, which had been known from the most distant period of time, namely, at the termination of two hundred and twenty-three lunations, which would occupy eighteen years fifteen days and eight hours. When this period had elapsed, there was an eclipse in all its important circumstances similar to the first eclipse, but in consequence of the time required being eight hours, as well as eighteen years fifteen days, the same side of the earth would not be presented

to the eclipse. This point was worthy of their attention, because of its connection with the two eclipses of 1842 and 1860.

There was an appearance which had been observed in various places, and which he should mention now, not because he had any respect for the accounts of it, but because it had been often referred to. It was known as "Baily's beads." As the totality approached, an appearance was observed resembling bright points interrupted by black spaces. He had looked for this appearance several times, but had never seen it. Probably that was because he looked carefully and with good telescopes, and that he believed they had never been seen except through bad telescopes. His friend, the late Dr. Baily, first observed them. He believed Dr. Baily must have had the misfortune to look through a bad telescope. In the year 1842 it was known that there was a total eclipse going on, but people generally did not understand what was to be seen, so little attention, comparatively, was attracted to it. Two persons only went from England to see it, of whom he (Professor Airy) was one. Well, they saw a total eclipse in its grandeur, and he might say in its horror. Nobody who had not seen a total eclipse could conceive what it was. No eclipse approaching to totality gave any idea of what it was when it was total. There were appearances about the eclipse of 1842 for which some of them were not prepared; but when their telescopes were turned upon the moon, there were appearances for which none of them were prepared. Red flames were seen shooting apparently out of the moon. What could they be? The astronomers could make nothing of them, partly because they were not prepared to make observations on this point. After discussion, however, they came at last to this conclusion: that there were four flames projecting apparently from the moon. Similar appearances were found to have been mentioned twice before; but the whole subject remained in doubt until the eclipse of 1851.

On this subject he should make some remarks which would apply to the eclipse of 1860. Professor Airy exhibited three drawings, made by himself, of three different periods of totality in the eclipse of 1851, in each of which red flames were conspicuous. He described how these appearances diminished gradually on one side and increased in size on the other, and said that this first gave the notion that they were attached to the sun, because, had they belonged to the moon, they would have gone with it from one side to the other without change. But there were so many discrepancies in the different drawings made of these flames as almost entirely to upset all opinions about them. One observer, however, in Russian Poland, in whom he had the greatest confidence, saw them as he (Professor Airy) saw them, and mentioned an additional test, which tended to show that they belonged to the sun. Professor Airy alluded to the theory that these flames were due to what was termed the "interference of light," and explained why, in his opinion, this could not be. After 1851 there was the eclipse of 1858, which passed across Brazil, and was observed by some of the Brazilian authorities, and also by the French, who, let it be said, were never behindhand when any scientific subject had to be investigated. This eclipse was not seen from a very favorable situation, but it was very well observed, and one of

the most careful of these observers had distinctly remarked that the red flames disappeared on the one side, and reappeared unchanged on the other side, thus confirming his (Professor Airy's) observations.

He would now come to the eclipse of 1860. That eclipse began on the western coast of America at sunrise; it passed through South America to the south of Britain, thence to Spain, and through Algeria to the Red sea, where it terminated at sunset. Preparations were made to observe this great eclipse by different persons and bodies. The British government, at his (Airy's) suggestion, granted a large steamer — the Himalaya — for the purpose of conveying a large party of English astronomers to Spain, and it was principally from the observations of this party that he should make up the statement he was about to lay before the Association. The astronomer royal then proceeded to describe, by the aid of diagrams, the appearance of the corona, with respect to which he remarked that the accounts he received were a mass of discordance. He particularly alluded to the appearance of the planets Venus and Jupiter, which shone out near the sun as if there had been no sun in the hemisphere. Mr. Plantamour, of Geneva, who went to a place on the eastern coast of Spain, took three drawings — at the beginning, the end, and the middle of totality. What he depicted seemed to show that the appearances were produced by something like a cloud, or a cloudy atmosphere, between the earth and the moon. It could not be from anything in our atmosphere. Was there an atmosphere extending from the earth to the moon? He (Professor Airy) declared that he knew not; but he knew nothing else that would account for what Mr. Plantamour depicted. The whole train of observations on the corona led him (Professor Airy) to believe that there was some reflecting medium extending almost, if not quite, from the earth to the moon. He did not know whether that was incompatible with what was known of the interplanetary atmosphere; but there was nothing else that supported these appearances, and this theory did so in some measure. It was also supported by the observation of polarization. When light was not reflected, it was only the common vulgar light; but when reflected from the surface of a transparent medium, it received the modification of polarization. So, when that modification was discovered, it was inferred, with great probability, that the light had been reflected. If we did that, we should be going a long way towards showing that the light in this case was produced by something like an atmosphere intermediate between the earth and moon. The learned professor showed, by an experiment, that two images of light, in the ordinary state, could be made to revolve round each other without alteration in intensity; but that, when reflected from unsilvered glass, the lights disappeared alternately while revolving; and that the same effect resulted when the rays were colored. Some of the Himalaya party were prepared specially to observe whether the light from the corona or other parts was polarized. The result was this: Some of the English observers were abundantly satisfied that the light of the corona was polarized; but they could not decide whether or not the polarization was of a character that implied reflection in the plane passing lengthwise of the rays; but one of the foreign observers who went to the east of Spain saw that it was so

polarized. This was in every way consentaneous to the idea that the light of the sun was deflected in some way to form the corona. If that was so, he (Professor Airy) knew of no explanation but that there was something like an atmosphere extending to the moon, or possibly further. The red prominences were seen in great beauty during this eclipse. The question had been raised, whether they belonged to the sun, the moon, or something intermediate. By means of a model, Professor Airy showed that if the prominences belonged to the moon, they would follow her; but if they belonged to the sun, they would be shortened on one side and lengthened on the other, during the passage. *Prima facie*, this was a strong argument that they were parts of the sun. But Mr. Fahey pointed out this: — Supposing a prominence at the top of the sun; when totality was just beginning, it would be to the left of the moon's centre; it would be over the centre as the moon advanced, and would pass on to the right of the moon's centre as the eclipse advanced. It was impossible that these fantastic appearances could be represented in the same manner by all parts of the moon's limb. Mr. Bruhn, of Leipsic, who went to the east of Spain, determined to observe particularly the brilliant cusps of the sun; and he recorded that the red prominences appeared before the sun had disappeared. He compared the position of one of the prominences with that of the bright cusp. The place of the cusp at a particular moment could be calculated with the greatest accuracy. He found that if the cusp belonged to the moon, it must have shifted twenty-six degrees on the moon's limb; but that if it belonged to the sun, it had not shifted one degree during the time he was observing. This was almost irresistible evidence that the red prominences were attached to the sun. In 1851, Mr. Busch, of Königsberg, took a daguerreotype of the moon and the prominences during the eclipse; but it was not a very successful attempt. In 1860, Father Secchi obtained five small photographs, and M. De la Rue two large ones; with these he had obtained data which satisfied him that the prominences were connected with the sun.

Some British officers stationed on the western coast of America observed the totality from Puget Sound, when the sun was only two degrees above the horizon; and he had received from them some admirable sketches. He thus had drawings of the red prominences as they appeared at Vancouver's Island, and on the eastern side of Spain, — just the extreme limits of the zone of observation. Were the prominences seen the same in the two cases? He could not say that they were, although he had tried to reconcile them. But was it likely that there should be a change? The total obscuration at Vancouver's Island was two hours earlier than at the eastern side of Spain; and if the sun was constantly boiling up, and these protuberances were from fumes, there was nothing to wonder at if there was a change during that time. All he knew was that there was no sensible change while the eclipse was passing over Spain. If attached to the sun, could we see these red prominences at other times than during an eclipse? And if not, why not? He had tried all he could to do so with apparatus, but had never succeeded. He lent the apparatus to Mr. Piazzi Smyth, when he went to the Peak of Teneriffe; but that gentleman failed to see the protuberances. But

that did not at all detract from the evidence of their attachment to the sun; for we never could cut off completely the highly-illuminated atmosphere through which we look at the sun and all about him. Cut off all we could, there would still be a blaze of light that would extinguish anything even much brighter than these prominences.

ASTRONOMICAL SUMMARY.

The Ring of Saturn. — Mr. Lassell, the English astronomer, in a recent notice in the (English) Astronomical Society's Journal, states that he has observed that the black shadow of the ring of Saturn, in passing the ball or planet, is evidently knotted or notched, thus conveying the idea of mountains upon the plane of the ring, intercepting portions of the thin line of shadow, and almost breaking it up into a thin line of dots. Capt. W. S. Jacob, of Hartwell, who observed the same phenomena, May 19th, 1861, is, however, inclined to attribute them to the variation in the shade or tone of the shadow, by which the darker portions appeared to project beyond the rest.

Movements of Sirius.—It has been for a long time known to astronomers that there were certain anomalies in the motion of the bright fixed star Sirius, which could not be explained by reference to the aberration or refraction of light, or to imperfections in the instruments employed in observation. Mr. T. H. Safford, of the Cambridge (Mass.) Observatory, who has recently been engaged in investigating the phenomena in question, considers, as the results of his researches, that the following propositions may be received as certain: —

1st. That the motion of Sirius in declination is not uniform.

2d. That the deviations from uniformity are readily explained upon Bessel's hypothesis, that Sirius is, as to its visible position, not the centre of gravity of its own system; in other words, that there is a large invisible mass present in that system.

The legitimate conclusion from these premises is, that the star Sirius revolves around an invisible companion at a very considerable distance from its optical centre. This period of revolution is believed to be about fifty years.

Hole in the Moon. — Messrs. Bout and Mannheim, who were sent by the French government to Algeria, to observe the great solar eclipse of July, 1860, state, in their official report, that they both saw, one with a telescope, the other with the naked eye, a luminous point on the moon's disc. This phenomenon was perceived by Admiral Ulloa and his companions, in 1778, and by M. Valz, at Marseilles, in 1842; but it has hitherto been considered an illusion. M. Mannheim states, however, that he saw the brilliant point so unmistakably as to leave no doubt of its being a reality. Its place on the lunar disc has not yet been determined; but, should it prove to have been always seen at the same place, the only explanation possible would be that the moon is pierced with a hole.

Recent Researches on Comets. — During the last eight years twenty-two new comets have been added to the list of our luminous visitors, including the most superb one of our age, first seen by Donati on the 2d of June, 1858, and that which flashed with scarcely less

brilliancy upon our astonished sight on the last evening of June, 1861. The successive returns to perihelion of the comets of D'Arrest, Brorsen, Encke, and Faye, have enabled the elements of those bodies to be re-observed, and their periodicity to be observed with an increased degree of accuracy. Professor Encke, in particular, has discovered, in the course of his researches in relation to that called by his name, additional indications of the existence of a resisting medium affecting the orbital motion of the comet, and accelerating, in consequence, its successive returns to the perihelion. This retardation he has ascertained to amount, during nine revolutions of the comet, to 4,544 days.

M. Dove, of Berlin, has recently addressed a paper to the Prussian Academy, in which he asserts that neither the comet of 1861, nor in fact any comet, ever shone with its own, but with borrowed light. There would, therefore, be no longer any danger to be apprehended from a too near approach of these erratic bodies to the earth; as they do not burn, they cannot ignite.

New Star Charts. — Sir Henry James, chief of the Ordnance Survey of Great Britain, has prepared, and is about to publish, four very useful charts of the stars, and two maps of the world, with the lines of magnetic declination marked on them. The celestial charts are laid down on a geometrical projection of two-thirds of the sphere; two of them present the stars of the northern hemisphere, two of them those of the southern. The first map contains the European circumpolar regions, and has the great continent of Africa in the centre; the second gives the southern circumpolar regions. These maps represent the earth as it would appear to an observer at this point of sight, and very singular the configuration of land and water seems. To the scientific man these charts and maps will be of great interest and value.

Lescarbault's intra-Mercurial Planet. — During the past year (1861) a diligent and systematic search has been made at the Cambridge (Mass.) Observatory for the intra-mercurial planet (supposed to have been seen by Dr. Lescarbault) during the period assigned by mathematicians for its possible transit of the sun's disc. For these observations a five-foot equatorial telescope was used, to which was fitted a solar eye-piece, on the plan recommended by Sir John Herschel. The sun's image is reflected from the first surface of a glass reflector, so placed that the greater part of the incident rays are transmitted through the second concave surface, and are dispersed by it. The intensity of the light and heat is thus considerably diminished, and only faintly-tinted screens are needed to protect the eye. A very agreeable definition of the surface of the sun is obtained by this arrangement.

With this telescope, the surface of the sun was explored from the 18th of January to the 12th of April; the search being made at intervals of one or two hours, from 9 A. M. to 4 P. M. The search, however, like others instituted in various other localities, furnished no testimony in confirmation of M. Lescarbault's observations.

The great Nebula in Orion. — Some interesting researches on the character of the great nebula in Orion have recently been made by Professor G. P. Bond, of the Cambridge (Mass.) Observatory.

The feature to which Mr. Bond's attention has been particularly directed is the spiral of the principal masses of light in this nebula; or, more correctly, the tendency to an arrangement in elongated wisps or whirls, sweeping outward from the bright region of the Trapezium. These peculiarities, which constitute the leading features of this nebula, have heretofore escaped particular notice. Mr. Bond describes the general aspect of the greater part of the nebula as that of an assemblage of curved wisps of luminous matter, which, branching outward from a common origin in the bright masses in the vicinity of the Trapezium, sweep towards a southerly direction. About twenty of these convolutions have been distinctly traced, while others, giving a like impression, are too faint or too intricate to be subjected to precise description. It may, therefore, be properly classed among "the spiral nebulæ," under the definition given by their first discoverer, Lord Rosse; including in the term all objects in which a curvilinear arrangement, not consisting of regular re-entering curves, may be detected.

Among other interesting observations noticed by Mr. Bond in this connection, is the disposition of nebulosity in the neighborhood of groups of stars or of single bright stars, apparently in preference to other localities; — an instance, perhaps, of the same distribution which we see among the smaller stars in some parts of the heavens, where they arrange themselves by preference in the neighborhood of the brighter ones, — the intermediate spaces being left comparatively vacant.

Bond's Isodynamic Escapement for Astronomical Clocks. — An isodynamic escapement for astronomical clocks, recently invented by Mr. Richard C. Bond, of Boston, greatly contributes to the removal of the small causes of error recognized as existing in the most perfect time-keepers hitherto constructed; and thus confers an important benefit upon astronomical science. Its principal peculiarities are, that it entirely obviates the difficulty arising from the varying power transmitted by the wheel-work, and also obviates the necessity of guarding against what is called *tripping*, or the danger of two or more teeth of the escapement wheel passing the pallets at once, when only one is intended to; thus causing the hands of the clock to gain by jumps, in the most unreliable manner, even while the pendulum is vibrating with perfect regularity. The construction of this escapement has been made public by Mr. Bond, in a pamphlet, accompanied by a diagram.

THE PERIODICITY OF THE SUN'S SPOTS.

Mr. O. Reichenbach, of Norristown, Pa., communicates to *Silliman's Journal* the following paper on the cause of the periodicity of the sun's spots, as determined by the observations of M. Schwabe, of Dessau. (See *Annual of Scientific Discovery*, 1858, page 397.)

The frequency of spots, in passing from maximum to minimum, embraces, according to M. Schwabe, a period of about eleven years. Now period by a primary cause oscillates by secondary causes. The revolution of Jupiter, the largest planet, is 11.86 years. There is affinity in these numbers. The maxima occurred in 1828,

1837, and 1848; another draws near; further off, six periods correspond to six revolutions of Jupiter; but I may be mistaken, and by a constant acceleration seven periods may take place. When we try to combine the days of observation, the number of spots and of spotless days, we find the increase and decrease to be in a slow ratio before and after the maximum, and the decrease and increase in a rapid ratio before and after the minimum, — a coincidence with the requirements of elliptic motion.

In 1828, 1837, and 1848 occurred the maxima. In 1827, 1839, 1851, 1862, Jupiter passed its aphelion. The first numbers coincide. The frequency of spots corresponds to the aphelion of Jupiter. The pressure at the perihelion, as my theory supposes, expands and increases the envelope; the aphelion condenses it, introducing a rapid alternation of precipitation and evaporation; the mass is thereby allowed to descend and meet in the equatorial regions, and the temperature is there increased. The numbers do not all coincide. But,

(1.) Do the maxima by groups of spots correspond to the greatest area and darkness? No days were spotless in 1829, 1838, and 1839; all those years produced spots of largest dimensions.

(2.) There are a number of other planets; if we abstract the far and slow, and the near and rapid small ones, the second central planet remains as the principal disturber. In 1827 Saturn was 10° (corresponding to the aphelion of Jupiter) in advance of its perihelion, and the number of spots was considerably less than in 1837 or 1848. In 1839 Saturn was 23° from its aphelion, advancing toward it. During the preceding years both planets advanced together towards their aphelions, and the greatest number of spots occurred before 1839. The reason of this anticipated maximum becomes obvious when we consult the position of the two aphelions. When the two planets draw near each other, the attractive force of the greater diminishes the spot-producing power of the smaller, the combined pressure on the sun is increased, the average distance diminished, the angular velocity of the greater augmented; whereas both planets advance in 1837 towards their aphelions in the latter half of the semi-orbits, but differ still about a quadrant in length; their spot-producing effect culminates; they exercise the least pressure, the least repulsion, on the *interior* sun. In 1851 Saturn was 60° from its perihelion, advancing towards it; beyond 48° its effect diminishes, the spot-producing effect of Jupiter still advancing to its aphelion. In 1862 Saturn will be 82° from its perihelion (in 1857–58 the time of the two perihelions pretty nearly coincides), advancing to its aphelion, and the maximum will be delayed till near that time. There is here a coincidence with the aphelion of Jupiter, but the maximum is in itself small. The next period, 1874, is brought down to 1872.

A relation between the "spots" and the oscillations of magnets is suspected; — it must exist. The planets must influence the magnetism. The effect from Jupiter on the earth must be large, as the latter, twelve times revolving, passes at one time between the sun and that planet in its perihelion, and then in its aphelion. The earth is now pressed, now elated, — its envelope now expanded, now condensed, — between these two rotating balls, magnets, or voltaic piles, or weights,

or whatsoever they are called with reference to phenomena classed under these various denominations.

RAIN FOLLOWING THE DISCHARGE OF ORDNANCE.

Mr. J. C. Lewis communicates the following note to the *National Intelligencer,* on the above subject:—

"In October, 1825, I took note of a very copious rain that immediately followed the discharge of ordnance during the celebration of the meeting of the waters of Lake Erie and the Hudson, upon the completion of the Erie Canal; and in 1841 I published my continued observations on the subject, which, to my mind, fully established the fact that the discharge of heavy artillery at contiguous points produces such a concussion that the vapor collects and falls generally in unusual quantities the same day or the day following.

"The early battles of the late war between the French, Sardinians, and Austrians, were succeeded by such copious rains that even small rivers were not fordable; and during the great battle of Solferino a storm arose of such fierceness that for the time the conflict ceased. In the month of July the armies on the upper Potomac fought four different battles on as many days, and there were extensive rains before the close of each day. July 21st, the great battle of Bull Run, Virginia, was fought, and next day (22d) the rain was copious all day, and far into the night."

Great Rain-fall in Ohio.—Mr. S. B. McMillan, in a communication to *Silliman's Journal*, gives an account of a very remarkable fall of rain which took place in Ohio, August 12th, 1861, extending over at least a hundred square miles. The total amount that fell in eleven hours was 8.01 inches, and of this quantity 4.29 fell in four and a half hours.

GEOGRAPHY, ANTIQUITIES, ETC.

GEOGRAPHICAL DISCOVERY AND INVESTIGATION IN 1861.

The year 1861 opened with the most brilliant prospects for geographical discoveries. The scientific men, both of England and America, expected that in its course some unknown parts of the earth would be explored, and several important problems solved. Two expeditions, one from Sweden and the other from the United States, were fitted out to go in quest of the North Pole; five different parties, in as many different directions, were searching for the sources of the Nile; a bold project to traverse China and Thibet westward, from the Yellow Sea to the Himalayas, seemed near its execution; and Australia was to be explored by two expeditions, following different routes, from the southern to the northern coast. But all these schemes have failed, more or less signally; scientific travel has been almost everywhere unfortunate; an evil star seems to have reigned; and the year is to be remembered, not for its accomplishments, but for its disappointments.

Swedish Polar Expedition.—A Polar expedition, under Prof. Torell, equipped on a magnificent scale, chiefly by the Swedish Government, and composed of eminent Swedish and Danish naturalists, and of students from Upsal and other universities, sailed from Tromsoe on May 9, 1861, reached a bay on the north of Spitzbergen, lingered there, and advanced no further. The ships were blocked up by the ice, and an attempt to proceed by sledges soon brought them to an open sea. There was ice enough to repulse the ships, and sea enough to stop the dogs. The experience of Torell demonstrates that though sledge excursions may be available on the American side of Greenland, the only way to reach the Polar region east of Greenland is by a steamer specially designed for the purpose.

Hayes's Arctic Expedition.—The Polar expedition, under Dr. Hayes (the companion of Dr. Kane), which left the United States early in 1860, with a hope of penetrating, through Smith's Straits and Kennedy's Channel, to an open circumpolar sea, returned October, 1861, after an absence of fifteen months. The expedition, so far as its main object was concerned,—namely, the determination of the question of an open Polar Sea,—was a failure. The ice prevented Dr. Hayes from penetrating with his vessel as far north as he intended, and he was obliged to make his winter quarters in a bight at the head of Hartstein Bay, which he named Port Foulke. His explorations during the winter were delayed by the loss of his dogs by disease, and Mr. Sontag, the astronomer, was frozen to death while going south-

ward with Hans, the Esquimaux of the Kane expedition, in search of Esquimaux from whom to purchase dogs. In March, 1861, a sledge expedition northward, up Kennedy's Channel, was undertaken, which went as far north as 81° 35′, a latitude which is said to have been before reached only by Parry, in 1827–28. On the coldest day experienced the thermometer fell to 68° below zero. Rensselaer Harbor, Dr. Kane's winter quarters, was visited, but no trace of his abandoned vessel, the Advance, was discovered. Although thus early in the season (March), the ice in Kennedy's Channel was everywhere much decayed and unsafe, and in some places was entirely gone. In one extensive pool a flock of water-fowl was discovered.

The chief results of this expedition may be summed up as follows:— the completion of the survey of Smith's Sound; the discovery of a new channel at the westward of Smith's Strait; the determination of the magnetic dip, and of the declination at many points within the arctic circle; surveys of glaciers, by which their rate of movement is determined; pendulum experiments, etc. etc.

A Central Asiatic Expedition, projected by Capt. Blakiston of the British Army, and starting from Shanghae, China, has also proved a failure. Instead of penetrating from the east to the headlands of the Indus and the Ganges, retracing the steps of the Abbé Huc, and advancing beyond the holy city of Lamaism, Capt. Blakiston found himself unable, on account of the rebellion, to reach even the western boundary of China proper, and returned to Shanghae, after an absence of five months.

Australian Expedition.—In Australia, an expedition for exploring the interior of this island-continent, led by Mr. O'Hara Burke, and which left Melbourne August, 1860, has resulted most disastrously. Mr. Burke and many of his party died from starvation and exposure, and the few who returned endured the greatest sufferings.

In addition to these unfortunate enterprises, the several expeditions for exploring the Upper Nile, projected or under way at the commencement of the year, have all returned without being able to penetrate the country as far as the limit attained to by previous explorers. Dr. Livingston, in Central Africa, when last heard from, had also been unable to add anything of moment to his earlier discoveries. Within the last few years, moreover, seven African explorers have found their graves in the inhospitable regions of that country.

But the year has not been altogether disastrous to geographical explorers. An Australia expedition, under the command of John McDouall Stuart, has achieved a measure of success in exploring the unknown districts of this country. With his companions and thirteen horses, Mr. Stuart left South Australia, lat. 29° 35′, in March, 1860, with the intent of crossing the continent, from coast to coast. As he proceeded toward the interior, instead of meeting with an arid desert, he found a well-watered country, cut up by numerous rivers and creeks, and covered with an abundance of grass and scrub. By the middle of June the party were in the geographical centre of the island-continent. Beyond this they began to encounter difficulties. The soil became sandy, water was scarce, and, instead of following a north-west course, they were obliged to turn somewhat to the east, in

the direction of the Gulf of Carpentaria. At last they arrived in sight of a chain of mountains which appeared to be composed of igneous rocks, giving evidence of the existence of mineral wealth. Here they met a large party of natives, who resisted all attempts at a parley, and greeted the hapless explorers with showers of boomerangs. They were compelled to return, and reached their starting point in September, having travelled two thousand three hundred miles in six months and two days. Their furthest point was two hundred and fifty miles south-west of the Gulf of Carpentaria, in the extreme north. Had they therefore been allowed to proceed a few days longer, they would have reached the northern coast of Australia, and have fully accomplished their object.

Admiral Hope, of the British Navy, has succeeded in ascending the great river of China, Yang-tse, to a distance of five hundred and seventy nautical miles from its mouth, without any accident; and it was stated that it was navigable for a hundred and fifty-seven miles further up, making in all seven hundred and twenty-seven nautical, or about eight hundred and forty-two statute, miles from the sea. The Yang-tse, therefore, although it be, in point of navigation, neither the Mississippi nor the St. Lawrence, far excels the Ganges, the Rhine, and the Danube; — is, indeed, the finest navigable river in the Old World.

A party of French officers have succeeded, during the year, in crossing the Great Sahara Desert, and visiting the sources of the rivers Gambia and Senegal.

A Dutch party has lately made a partial exploration of New Guinea. On the western coast they found a group of six islands, the largest of which, Salo Adi, is twenty-five miles long, and five broad. They entered the great Papuan island, near the spot where the river Karufa empties into the sea. This stream rises in the mountain range nearest the coast, flows through alluvial soil covered with jungle, and discharges its waters by five mouths. The portion of the island visited is described as a level plain, from which rises, towards the north-east of the Karufa mouth, a chain of mountains two thousand feet high. To the west is a second range of limestone hills, through a break in which a sharp and lofty peak was discovered, having the appearance of a volcano. A dark green forest overspreads the whole region.

Mr. David Forbes, a Scotch geologist, has been engaged for some years in a geological exploration of Bolivia and Southern Peru. He states that the remarkable saline plains of that portion of South America extend through the rainless regions for a distance of five hundred and fifty miles, yielding prodigious quantities of nitrate of soda, and considerable deposits of borate of lime. One hundred thousand square miles of the great chain of the Cordilleras are now known to consist of silurian rocks, and to contain fossils to a height of twenty thousand feet.

Natural Geographical Changes. — Attention has recently been drawn to certain important geographical changes which are in the process of accomplishment in Western Asia. The Sea of Azof, the outlet of the commerce of the Don, is rapidly becoming a vast and impenetrable marsh. Between two measurements, thirty-two years

apart, its depth has diminished eleven feet; and the prediction of Strabo may yet be accomplished, that some time both the Sea of Azof and the Black Sea will become a waste tract of intermingled lakes and morasses. The largest river of Central Asia, the Oxus, according to the unanimous testimony of ancient authors, rolled its waters into the Caspian Sea. In modern times it has emptied into the Sea of Aral. But it seems to be about to resume its ancient channel to the Caspian, — an event which would revolutionize the conditions of commerce between Europe and Asia. The Oxus would then recover its renown as a great highway of nations. The Euphrates also is leaving its ancient bed from a point above Killah, and taking a more westerly course. Year by year the new channel receives a large proportion of its waters; the stream that adheres to the old channel has already ceased to produce the inundations which, like those of the Nile, can alone fertilize its borders; the country adjacent to the ruins of Babylon begins to wear the aspect of hopeless aridity; and the ancient capital of Semiramis and Nebuchadnezzar will soon make the centre of a desert. Nor does the river promise to fertilize a new district, but loses itself in the innumerable lakes and marshes which extend to the Persian Gulf.

OPENING OF A TOMB AT THEBES.

The London *Literary Gazette* publishes a description of the recent opening of a tomb in the vicinity of Thebes, Egypt, by a party of English gentlemen engaged in explorations, which possesses some peculiar features of novelty and interest. The preliminary part of the description is taken up with an account of the locality and methods of exploration followed; the disappointment experienced in finding that nearly all the tombs, laid open by tedious and expensive excavation in the side of a valley, had been previously opened and ransacked, and the final discovery of a tomb which had escaped previous visitation. Subsequent events, however, showed that even this tomb had not remained in possession of its *original* occupants, but had been taken possession of by an Egyptian of rank, belonging to some much later dynasty, who was now in turn disturbed by the present explorers.

The entrance to the tomb, which was walled up with stones laid in cement, having been broken into, a rock-cut hall and winding tunnel were revealed. The last descended to a depth of twenty feet into the heart of the rock, its sides at the termination being pierced with doorways leading to chambers. At this point we take up the narration as detailed by one of the explorers: —

Beginning with the chamber opening to the north, I shall designate it as No. 1, distinguishing the others as Nos. 2, 3, and 4, in the rotation of east, south, and west.

No. 1, being not quite ten feet long, and five feet six inches in breadth, was little more than large enough to accommodate its contents. Side by side on the floor, and almost in contact, there was a heavy and rather ill-finished mummy case, painted in white and blue, of the usual form, shaped like the swathed body, and a plain, unsmoothed deal shell or box, dovetailed at the corners. On the breast

of the former a wreath of leaves was twined, and above the feet there rested the tiny bodies of two very young children, covered only by a few folds of simple bandages, the outer rolls of which encircled them together. The latter also bore a similar but a heavier burden, the mummy of a full-grown man carefully swathed, the exterior cloth being painted to represent the lineaments of the face, the hands, and the feet, with a line of hieroglyphics from the neck down the front to the extremities.

The box, which was merely the simplest form of a deal coffin, contained an undecorated mummy; and the large case; its neighbor, enclosed two, one the body of a man, the other of a young girl, accompanied by two bracelets of bronze or copper, two coarse anklets of iron, and an ear-ring of something very like the same metal, whited or silvered.

The prominent feature connected with this burial was the slight degree of trouble that had been expended to prepare the mummy-case for its later occupants. It had undoubtedly been constructed for a very different tenant — for a tenant of much earlier time, and probably had held the remains of one of the first owners of this tomb; but whether it had been thus procured on the spot where it was again employed, or not, the method of appropriation had been very summary. For the lid, which showed marks of having once been violently wrenched off, was only laid loosely on, the fractured slips or tongues of wood which had originally secured it not having been restored to efficiency, while they were in some cases completely broken away. Nor could this be explained by assuming, with reference to the presence of two bodies, that the coffin had first been deposited with one, and subsequently, as a manifestation, even in death, of earthly affection, opened to receive the other, that of the young girl, which was uppermost; for, besides the evidence of rough usage, it was plain that the case was made having reference to a mummy of different dimensions from either of those within it, and intended to be differently disposed. The corroborative analogy of other facts observed in the tomb likewise went to prove that here was an instance of appropriation more remarkable than those occasionally met with, from its improvised and certainly undisguised character.

Chamber No. 2 was closed by a wooden door, and contained one large coffin, of the plain, uninteresting type, constructed with square pillars at the corners, one long panel in either side, and a semi-circular top. In this instance, a hieratic inscription on the end was a distinguishing peculiarity.

Chamber No. 3, being ten feet four inches by nine feet seven inches, afforded ample space for the three similar mummy cases which were stored in it.

In chamber No. 4 stood a massive sarcophagus, of the dark granite of Assouan, quite unpolished, and chiselled no more than was necessary to bring it into shape. Immediately in front of it, and protruding into the shaft, lay some of the appliances which had doubtless been used to move the cumbrous mass; and the presence of the old workers was singularly recalled, even here in the depths of the grave, by rollers and planks, which they had left on the spot where their mechanical ingenuity had employed them. The planks, too, were

another proof of the reckless disregard with which the older occupants of the tomb had been treated; for they were the sides of broken mummy-cases, covered with hieroglyphic groups in the style which I have met with on coffins of the period of the eighteenth, nineteenth, and other dynasties of the revived empire.

Likewise at the door of this vault, but in the shaft rather than within it, lay a tall, cylindrical jar, inscribed near the neck with a short line of hieratic, and nearly filled with the fruit of the Dom palm. Several more nuts of this tree were also strewed about, and they were very frequent accompaniments of the Egyptian dead.

At the head of the sarcophagus four curious objects were carefully disposed: a figure about sixteen inches long, internally formed of reeds and linen, and swathed in imitation of a bull, like those from Memphis; a mummied ibis; a spirited copy of a small hawk on a pedestal, rather decayed, but apparently constructed of folds of linen cloth gummed together, and an oblate ball of bitumen from three to four inches in diameter. The first was evidently designed to represent, or had reference to, Apis, or perhaps rather to Mnevis, whose worship was celebrated at the neighboring Hermonthes (Erment). The ibis was the emblem of Thoth, the hawk of Horus — both of them deities whose attributes were of striking import to the departed spirit. And in the ball of bitumen was imbedded a coiled snake, likewise a symbol of marked significance in connection with the future.

The inner end of chamber No. 4 communicated with another, No. 5, which contained one more pillared mummy case, with a festoon of crumbling evergreens resting upon it. At the farthest corner of this vault was the entrance to yet another, on a slightly lower level, and nearly filled with stone chips and rubbish, among which were no traces of sepulchral remains. This was the limit of the subterranean gallery, whose extreme length from the end of this chamber, through Nos. 5 and 4, across the shaft, and on to the end of No. 2, was fifty-six feet. The height of the vaults was within two or three inches of five feet, and their roofs were encrusted with dependent crystals of salt.

Such were the deep recesses of the tomb, such the method in which the dead had been left to their rest, as every object probably remained in precisely the position it had occupied when the funeral rites were performed over the last who had "*gone down* into this pit." For had its gloomy silence been ever broken by explorers during any of the subsequent centuries through whose long course treasure-seeking has more or less vigorously flourished, it would not be conceivable that the mummy-cases should stand intact, and particularly that an imposing receptacle like the sarcophagus, so well calculated to excite the hopes of cupidity, should be permitted to retain, unattempted, the mystery of its interior. But the time had come when those who had reposed so long were to be disturbed in turn, although there were no successors to be established, as they had been, in the places of which the occupants were to be dispossessed. The tunnel above and the vaults beneath were fully lighted up, the grim corridors resounded with the song of a selected band of brawny fellaheen as they pulled at the hoisting ropes, and the old beams, erected over

the shaft, once more bore the unanticipated weight of the coffins which they had helped to lower to a home that might almost have been deemed as permanent as the duration of time itself.

The size and weight of the granite sarcophagus would have rendered it extremely difficult of removal from its site, had that been desirable or necessary; but every purpose was answered by subjecting it to examination where it stood. The solid cover, freed from the cement with which the joint was seamed, was easily raised from the bed, on which it simply rested, without any of the contrivances for fastening it down that sometimes are seen to have formed part of similar relics. And then the subject of all this care was disclosed, surrounded by yet another precaution for its security. Under, above and around the mummy, the whole sarcophagus was filled with bitumen, which had been poured in hot, forming a compact mass, adhering at all points with such tenacity as to require the most patient labor for its liberation from the body.

At length, however, the object was safely attained, and subsequently, in the upper air, the crude encrustation of bitumen peeled readily away from the outer wrappings of the mummy.

At a very early stage of the process the bright glitter of the leaf of a golden chaplet aroused to the wildest pitch the extravagant speculations which the fellaheen always entertain with regard to the probable contents of tombs of considerable extent. The presence of treasure was whispered about, and, as many of the people in the neighboring villages had been looking forward with great interest and absurd anticipations for the final result of this particular excavation, a marvellous report, magnifying as it spread, found willing ears, and in an incredibly short time pervaded the whole district for miles on either side. The story is now, probably, a fixed tradition, and it might be attempted in vain to shake the established belief that I procured a profuse amount of gold and jewels of dazzling value.

And this was what gave origin and color to the fable. The head of the mummy was cased by a gilt mask, outside of which, around the temples, a circlet reposed. It consisted of a ring of copper thickly gilt, the diameter of whose metal was nearly half an inch, and twelve bay leaves, in thin gold, were attached to it by their pliant stalks.

In this manner the head of the mummy was adorned, and the outer cloth covering of the rest of the body was painted in colors, designed in a diagonal pattern.

Beneath this outer cloth were a great number of folds of plain (unpainted) cloth, which were so saturated with bitumen and pungent gums as to form one concrete and almost homogeneous mass with the body which they encased. Imbedded among them it was difficult to detect a small thin plate of gold in the shape of a winged scarabæus, and several pieces of vitreous composition, portions of emblems which had been studded in the bitumen after a well-known fashion, better illustrated in the case of another mummy to which I shall subsequently allude. From the usual position on the left side, a fine if not large roll of hieratic papyrus was recovered, without, fortunately, suffering any injury. I could not venture to attempt opening it here, as the application of the necessary aids by ingenious hands will be requisite; but one corner gives evidence of its being illustrated in colors, while

the figure disclosed is of a character, I fear, to indicate that the document is simply of the usual class, a copy of some portion of the ritual.

The bearer of the scroll was a man of mature years, with features strongly marked as far as the cerements permitted their characteristics to be discerned. The skin of the upper part of the body had been gilt with thick gold leaf; and the arms, which were rolled separately, but only by a single bandage, were brought down by the sides, with the hands resting under the thighs.

All the other mummies in the pillared cases were laid in the same attitude, and the upper portions of several of them were likewise gilt. With one, also, there was another hieratic papyrus, but of inferior material, execution, and size. Another was decorated with a gilt mask; and another, being a handsome specimen of the style of ornamenting externally with small objects, in the manner which to some extent prevailed on all, I propose to remove untouched. In this instance the compact bituminized cloth began to occur beneath not more than two outer layers of the ordinary linen, and here, on the black ground, the figures were inlaid. First there was a blue-winged scarabæus on the throat; then a small winged globe of thin gold; lower still, on the breast, another larger agathodæmon, with more distended wings, also in gold; and beneath, another thin plate of the same metal, representing Anubis bending over the deceased. Over the spot of the ventral incision, on the left side, were the four genii of Amenti, composed of what might be termed a mosaic of variegated pieces of vitreous composition; and two crowned hawks of Horus, of the same material, were imbedded one on each shoulder.

The history of the sepulchre whose details I have thus attempted to describe, may, with no great difficulty, be surmised. Most of the painted tombs in its vicinity, in the same hill, date from the older dynasties of the revived empire, and there is every reason to believe that it also had been excavated and used at a period quite as early. Indeed, the tomb immediately adjoining, whose door I discovered first in the same area, which must, to all appearance, have been cut with equal reference to both, was sealed with the cartouch of Amunoph III., of the eighteenth dynasty, and, in all reasonable probability, this indicator of age may be fairly held as of common application to the two. Nor would this conclusion be otherwise than countenanced by the style of mummification and decoration of the rifled bodies and coffins found in the built-up chambers above, and in vault No. 1 below.

Whether the original occupants were allowed to sleep on in peace until the time of the last appropriation, or whether their right of property had been occasionally infringed in the interval, or themselves, and others also, in turn, displaced, according to a not unusual practice for adding to the priestly revenues, can only be conjectured. But twelve or perhaps thirteen hundred years must have elapsed before possession was so rudely taken, and the forcible and final innovation accomplished which left the place in the condition in which I found it. Then, probably a century or so before our era, a complete and radical change was effected. The older mummies were, as we have seen, spoiled and ejected, and their home usurped amid circumstances which cannot but excite surprise.

The style of mummification, and other accessories of burial, all indicate the age of the later deposit as that of the close of the Ptolemaic rule. As regards the connection between the persons who in this tomb were so closely associated in death, there is no difficulty in supposing the occupants of the sarcophagus and of the five pillared cases to have been related by family ties; but between the former and the man, for instance, who had no more handsome coffin than the plain box like a work-house shell, there appears a broad line of separation; nor does it seem that their juxtaposition can be easily accounted for, except by some such supposition as the dependence of the one upon the other, or upon some former member of his house. That the chief of the group in the granite sarcophagus was the last deposited is highly probable. The planks and rollers, even a chip of coarse pottery, holding the residue of the cement which had been used to fasten down the lid, all left lying upon the spot, would almost indicate that no future preparations had been made for another body; otherwise, these would, in all likelihood, have been removed. Having witnessed vicissitudes like these, changes still more uncontemplated by the old designers await this sepulchre. For full three thousand years it has been dedicated to the departed. It will now begin a new episode as a dwelling for the living. Two days had not elapsed from its opening, when its possession was sought for by the Arabs, and operations commenced for converting it into a habitation. In its chambers, hereafter, degraded generations shall be born and die content with a shelter almost among the bones of, it may be, far distant ancestors.

THE LAND OF BASHAN.

At a recent meeting of the Royal Asiatic Society, the secretary read a paper communicated by Cyril C. Graham, Esq., which accompanied a number of ancient inscriptions, in an undeciphered alphabet, which he had found in the great desert land, left blank upon our maps, east of the Hauran, which was known to the Hebrews as the Land of Bashan. Mr. Graham, being in Damascus last year, had been animated with a desire to penetrate to the East by the sight of the mountains visible in the distance from the high ground about the city. Those mountains were known to lead to the extensive rocky region called El-Safah, near which the Arabs had reported there were to be seen many ruins of ancient cities, — a region similar in its features to the El-Lejah, in the Hauran. He set out upon the expedition in the month of September; and was lucky enough to make an agreement with the Ghias tribe of Arabs in the most eastern part of the Hauran (the limit of European exploration in that quarter), to accompany him to the regions he wished to visit. Soon after the party had quitted the Hauran, they entered upon a plain covered with basaltic rocks, lying loose on the ground, but so closely packed that it was with the utmost difficulty the camels could pick their way. This stony tract, which extends from east to west a distance of five days' journey, and from north to south two days', is called by the Arabs, El-kharrah. Within it is the district called Es-Safah, a volcanic region, which he describes by conceiving a quantity of molten matter confined in a vessel, stirred up by a powerful agent, and then

allowed to cool suddenly. It resembles the district El-Lejah in the Hauran. The direction of the Safah is nearly north and south. There is not a single tree on its surface; but a chain of hills of forty miles in length runs through it, nearly in the same direction, varying slightly to the north-west. Mr. Graham did not venture to cross this "volcanic island," but he coasted it towards the south, and passed it on that side to the western plain, to seek for the ruined cities of which he had heard. Soon after, his attention was attracted by a large stone, having an inscription upon it, in an unknown character, which he carefully copied. He began then to imagine that the stones he had found had been set up to mark the distance from some important town; that, in fact, they were mile-stones. While reflecting upon this fact, he came suddenly upon a ruined town, built of white stone, of a kind of which no specimens whatever were seen by him on the plain, the whole of which consisted of a dark-colored lava. Four similar towns exist around the Safah, but in none could he find any inscriptions, though many curious and rude sculptures were lying about. From this place Mr. Graham continued to proceed a few days' journey further westward; and in several places he found small areas of three hundred or four hundred yards in circumference, in which almost every stone had upon it the rude representation of camels, gazelles, apes, horses, horsemen, etc., always accompanied by inscriptions. Of these about twenty were laid upon the society's table. Many of them were from a *wadi* called El-Nemarch, south-east of the Safah, where there were many thousands of inscribed stones. Others were taken from another *wadi* further to the east, called Warran. It was on this spot that a singular relic of red stone, or of a very compact kind of pottery, was found. The relic is a sort of baton, of about eighteen inches in length, and perfectly smooth. The inscriptions copied were in a very small proportion to the great numbers scattered about; but the fear of the Arabs of their enemies, the Anezi, who were in the neighborhood, and the want of water, prevented a longer stay in the place. The Arabs had no traditions regarding these inscriptions, or the people who had executed them, but they agreed that all the inhabitants had been driven away by Tamerlane! The inscriptions are in a rude character, which has analogies with the oldest Greek and Phœnician alphabets; and it is not impossible that they may have been old enough for a time when the two alphabets were nearer to the one original than we find in any other case. No serious attempt has yet been made to read them; but should they be either in Greek or Hebrew, no great difficulty is apprehended in doing it. Some read from right to left, and others from left to right. They are, unfortunately, very short.

OPENING OF A TOMB OF THE ANCIENT ETRUSCANS.

The following is a description of the opening of a subterranean tomb of the date of the Etruscans, recently discovered near the site of the ancient Vulsino, and about five miles from the present town of Bolsena: —

"About eleven metres from the surface was the gateway, formed of basalt stone, but so displaced as to show that in very remote times

some one had entered it. The tomb measured about four metres square, and was about two and one-half metres high. On the left was found a colossal urn of basalt, the enormous lid of which, on the point corresponding to the face of the dead, had a large opening closed with a stone of similar character. The disarrangement of the bones shows that the objects of value had been already abstracted. Facing this, and within a small cell, an urn was found, about a metre in length, full of burnt bones. The lid, however, had been removed. Many bronze vases, upset and scattered about the tomb, left no doubt of the noble rank of the person to whom they belonged. These consisted of two large vases, of a singular egg-form, cut in the middle with a fluted pedestal, and 'listelli,' and 'ovoli,' of an elegant style. They rest on a square base, and have fluted handles, which are attached in one of them to four bearded human heads; and in the other only one handle was found, with female figures, with long hair descending behind the ears. The ornaments are of the most minute description, in imitation of pearls. There were found also two large vases of the kind called *secchie*. One of them had handles on one side, with the head of Hercules covered with the skin of a lion, whose mane adorned the cheeks, and whose paws were united beneath the chin. On the side whence issued the water there is also a Bacchanalian masque, with the front adorned with ivy-leaves. The beard served as a spout, and beneath this was a bearded man's head. Three jugs described as 'masiterni,' with saucers beneath them, ornamented with a fluted handle, and fashioned at the juncture after the manner of shells; — two small 'secchie,' the handles of which have on one side the head of a wolf, the lower lip of which served to pour out the liquid, and on the other the head of Silenus; two strainers for liquids; six small vases with handles; a small mystic glass, which, on the concave side, has two figures, and preserves the primitive gilding, — and other vases reduced to fragments by the first excavator. On each there is an Etruscan inscription. The objects just described are in a remarkable state of preservation, both as regards the exterior and the interior." — *London Athenæum.*

THE MAUSOLEUM.

An important collection of architectural and sculptural remains, excavated by Mr. Neuton (English consul at Mitylene) on the site of the Mausoleum, have been added during the last year to the British Museum. This monument, of which the site was first positively identified by Mr. Neuton, was erected by Artemisia, Queen of Caria to her deceased husband, Mausolus, about B. C. 350. It was esteemed by the ancients one of the seven wonders of the world, and is recorded to have been embellished by the sculptural skill of Scopas, Timotheus, Bryaxis, Leochares, and Pythis.

The remains of the Mausoleum thus far discovered and brought to England consist of —

Five marble fragments, forming, when united, the principal portion of a colossal horse, supposed to have belonged to the Quadriga, sculptured by Pythis, on the summit of the pyramid surmounting the building. On the head of the horse remain, though somewhat mutilated,

the bronze head-stall and bridle, which are believed to be the first examples discovered in modern times of a method of decoration habitually employed by the ancients.

The body of a horse, rearing, and ridden by a figure in Asiatic costume, of which the upper part is lost.

A colossal male statue, draped and erect, discovered in numerous fragments, which, having been now rejoined, present, with the exception of the arms, a nearly complete figure. The head exhibits a portrait conjectured, with some probability, to be that of Mausolus.

A colossal female figure, also draped and erect, without the head, hands, and left foot, but otherwise in fair preservation, though, like the preceding, discovered in fragments.

A colossal female Torso, draped and seated, much mutilated both in the extremities and surface.

A standing lion, of which the legs only are wanting, in fine preservation, and exhibiting the remains of paint inside the mouth.

Portions of at least seven other similar lions, more or less mutilated, the fore-parts of some of them having been in the Middle Ages removed and built into the walls of the castle at Budrum, from which they have now been obtained by the permission of the Porte.

Four slabs, and several fragments of slabs, from a frieze of the building, representing in high relief an Amazonomachia. They form part of the same series as the slabs removed in 1846 from the walls of the castle, and presented by Lord Stratford de Redcliffe to the British Museum; they are, however, generally in better preservation than those slabs.

The whole of these sculptures are executed in a style inferior only to that of Phidias, and form the most valuable representation yet discovered of the Greek school of the fourth century B. C.

The architectural remains of the Mausoleum, which accompanied the sculptures, include part of an architrave, a capital, base, and part of the shaft of a column, all of the Ionic order, and on a large scale.

Together with these is an extensive collection of marble fragments, architectural and sculptural, evidently from the same great monument, but of which the connecting links are still undiscovered.

INTERESTING EGYPTIAN ARCHÆOLOGICAL DISCOVERY.

The following account of an interesting discovery of a fragment of one of the "Orations of Hyperides," by Mr. Harris, the well-known Oriental scholar, is derived from the *London Athenæum:* —

In the winter of 1847 Mr. Harris was sitting in his boat, under the shade of the well-known sycamore, on the western bank of the Nile, at Thebes, ready to start for Nubia, when an Arab brought him a fragment of a papyrus roll, which he ventured to open sufficiently to ascertain that it was written in the Greek language, and which he bought before proceeding further on his journey. Upon his return to Alexandria, where circumstances were more favorable to the difficult operation of unrolling a fragile papyrus, he discovered that he possessed a fragment of the oration of Hyperides against Demosthenes, in the matter of Harpalus, and also a very small fragment of another oration, the whole written in extremely legible characters,

and of a form or fashion which those learned in Greek MSS. consider to be of the time of the Ptolemies. With these interesting fragments of orations of an orator so celebrated as Hyperides, of whose works nothing is extant but a few quotations in other Greek writers, he embarked for England. Upon his arrival here he submitted the precious relics to the inspection of the Council and members of the Royal Society of Literature, who were unanimous in their judgment as to the importance and genuineness of the MS.; and Mr. Harris immediately set to work, and with his own hand made a lithographic fac-simile of each piece. Of this performance a few copies were printed and distributed among the *savans* of Europe, — and Mr. Harris returned to Alexandria, whence he has made more than one journey to Thebes in the hope of discovering some other portion of the volume, of which he already had a part. In the same year (1847) another English gentleman, Mr. Joseph Arden, of London, bought at Thebes a papyrus, which he likewise brought to England. Induced by the success of Mr. Harris, Mr. Arden submitted his roll to the skilful and experienced hands of Mr. Hogarth; and upon the completion of the operation of unrolling, the MS. was discovered to be the terminating portion of the very same volume of which Mr. Harris had bought a fragment of the former part in the very same year, and probably of the very same Arabs. No doubt now existed that the volume, when entire, consisted of a collection of, or a selection from, the orations of the celebrated Athenian orator, Hyperides.

The portion of the volume which has fallen into the possession of Mr. Arden contains "fifteen continuous columns of the 'Oration for Lycophron,' to which work three of Mr. Harris's fragments appertained; and likewise the 'Oration for Euxenippus, which is quite complete and in beautiful preservation." Whether, as Mr. Babington observes in his preface to the work, "any more scraps of the 'Oration for Lycophron' or of the 'Oration against Demosthenes' remain to be discovered, either in Thebes or elsewhere, may be doubtful, but is certainly worth the inquiry of learned travellers." The condition, however, of the fragments obtained by Mr. Harris but too significantly indicate the hopelessness of success. The scroll had evidently been more frequently rolled and unrolled in that particular part, namely, the speech of Hyperides in a matter of such peculiar interest as that involving the honor of the most celebrated orator of antiquity; it had been more read and had been more thumbed by ancient fingers than any other speech in the whole volume; and hence the terrible gap between Mr. Harris's and Mr. Arden's portions. Those who are acquainted with the brittle, friable nature of a roll of papyrus in the dry climate of Thebes, after being buried two thousand years or more and then coming first into the hands of a ruthless Arab, who, perhaps, had rudely snatched it out of the sarcophagus of the mummied scribe, will well understand how dilapidations occur. It frequently happens that a single roll, or possibly an entire box, of such fragile treasures is found in the tomb of some ancient philologist or man of learning, and that the possession is immediately disputed by the company of Arabs who may have embarked on the venture. To settle the dispute, when there is not a scroll for each member of the company, an equitable division is made by divid-

ing a papyrus and distributing the portions. Thus, in this volume of Hyperides, it seems that it had fallen into two pieces at the place where it had most usually been opened, and where, alas! it would have been most desirable to have kept it whole; and that the smaller fragments have been lost amid the dust and rubbish of the excavation, while the two extremities have been made distinct properties, which have been sold, as we have seen, to separate collectors. So, at all events, such matters are managed at Thebes.

Mr. Harris mentions fragments of the "Iliad," which he had purchased of some of the Arab disturbers of the dead in the sacred cemeteries of Middle Egypt, most probably Saccara.

OBITUARY

OF PERSONS EMINENT IN SCIENCE. 1861.

ATKINSON, T. W., an eminent English traveller and explorer of Central and Northern Asia.

Audubon, Victor, an American ornithologist.

Berthier, Pierre, an eminent French mineralogist.

Berymann, Capt., U. S. N., well known for his connection with the Atlantic Telegraph enterprise, and for his ocean soundings.

Bishop, George, formerly President of the British Astronomical Society.

Blunt, Edward M., the well-known author of the "American Coast Pilot," and other nautical works.

Burke, O'Hara, an Australian explorer.

Burnett, Sir Wm., inventor of the "Burnettizing" process.

Casseday, S. A., an American geologist.

Clegg, Samuel, an English chemist, well known for his attention to gas and gas lighting.

Colt, Sam., inventor of the well-known revolving pistol.

Cordier, Pierre, Professor of Geology, *Jardin des Plantes*, Paris.

Cubitt, Sir Wm., an eminent English engineer.

Dauber, Hermann, an Austrian mineralogist of note.

Douglass, Sir Howard, the well-known English authority on gunnery.

Elderhorst, Wm., author of a work on the blow-pipe.

Evans, Dr. John, an American geologist.

Fairbairn, Sir Peter, an eminent Scotch engineer.

Hackley, Charles W., Professor of Mathematics in Columbia College, N. Y.

Henslow, Prof., an eminent English botanist and geologist.

Hilaire, Geoffry St., an eminent French naturalist.

Hodgkinson, Prof., an English engineer, best known for his researches on iron.

Ives, Dr. Eli, one of the earliest of American botanists.

Jobart, M., an eminent scientist of Belgium.

Kitchell, Wm., State geologist of New Jersey.

Klotzchs, Dr. J. F., a well-known botanist of Berlin.

Laird, McGregor, an English African explorer.

Lehmann, J. D., a botanist of note in Hamburg.

Paisley, Sir Charles, an eminent English military engineer and author.

Quekett, Prof., a well-known English microscopist.

Robb, Dr. C., Professor of Natural Sciences, University of New Brunswick.

Smith, Dr. Southwood, an English physician, eminent for his labors in behalf of sanitary reform.

Sontag, August, the astronomer of the Hayes Arctic Exploring Expedition; died from exposure in the Arctic regions.

Vilmorin, Louis, Dr., a French botanist, best known for his researches on the wheat plant.

LIST OF BOOKS, PAMPHLETS, ETC.,

ON MATTERS PERTAINING TO SCIENCE, RECENTLY PUBLISHED IN THE UNITED STATES.

Bailey, L. W. Notes on New Species of Microscopical Organisms. 8vo. Pamphlet. 1861.

Baird, S. F., J. Cassin, and G. Laurence. The Birds of North America. 2 vols. 4to. Philadelphia: Lippincott & Co.

Billings, E. On Certain Theories of the Formation of Mountains. Pamphlet.

Bland, Thomas. On the Geographical Distribution of the Land Shells of the West Indian Islands, with a Catalogue of the Species of each Island. N. Y.

Bond, G. P. On the Outline of the Head of the Comet of Donati, 1858, with a plate.

Bond, G. P. On the Relative Brightness of the Sun and Moon. 4to. Cambridge.

" On the Relative Brightness of the Moon and the Planet Jupiter. Cambridge.

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Chadbourne, P. A. Lectures on Natural History. 12mo. N. Y.

Deane, James. Ichnographs from the Sandstone of the Connecticut River. 4to. Boston.

Delafield, Maj. Richard, U. S. A. Report on the Military Systems of the Principal Nations of Europe. 4to. Washington. Pub. Doc.

Emerson, G. B., and Flint, C. L. Manual of Agriculture; an Elementary Treatise, for the Use of Schools, etc. Illustrated. Boston: Swan, Brewer, & Tileston.

Emmons, E., Dr. Swamp Lands of North Carolina.

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Gould, A. A., M. D. Report on the Mollusca and Shells of the United States Exploring Expedition. Folio. Plates. Philadelphia. 1861.

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Grey, Asa, M. D. Natural Selection not Inconsistent with Natural Theology. A Free Examination of Darwin's Treatise of the Origin of Species. Cambridge, Mass.

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Holmes, O. W. Border Lines of Knowledge in some Provinces of Medical Science. A Lecture. Boston: Ticknor & Fields.

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Horsford, E. N. On some of the Relations of Salts of Zinc and Alumina to Soda and Potassa.

Humphreys, Capt. A. A., and Abbott, Lieut. H. H. Report upon the Physics and Hydraulics of the Mississippi River; upon the Protection of the Alluvial Region against Overflow; and upon the Deepening of the Mouths; based upon Surveys and Investigations published by Authority of the U. S. War Department. 4to., with Maps and Plates. Philadelphia: Lippincott & Co.

Lea, Isaac, LL. D. New Unionidæ of the United States and Northern Mexico. 4to. 15 Plates.

Lea, M. Carey. Chemical Contributions to Silliman's Journal. Pamphlet.

Le Conte, J. L. Classification of the Coleoptera of North America. Part 1. 8vo. Smithsonian Institution Publication.

Lesquereux, Leo. Botanical and Palæontological Report of the Geological State Survey of Arkansas. 8vo. Pamphlet. Philadelphia.

Lieber, Oscar M. Notes of the Geology of Labrador.

McChesney, J. H. Description of New Fossils from the Palæozoic Rocks of the Western States. Chicago.
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